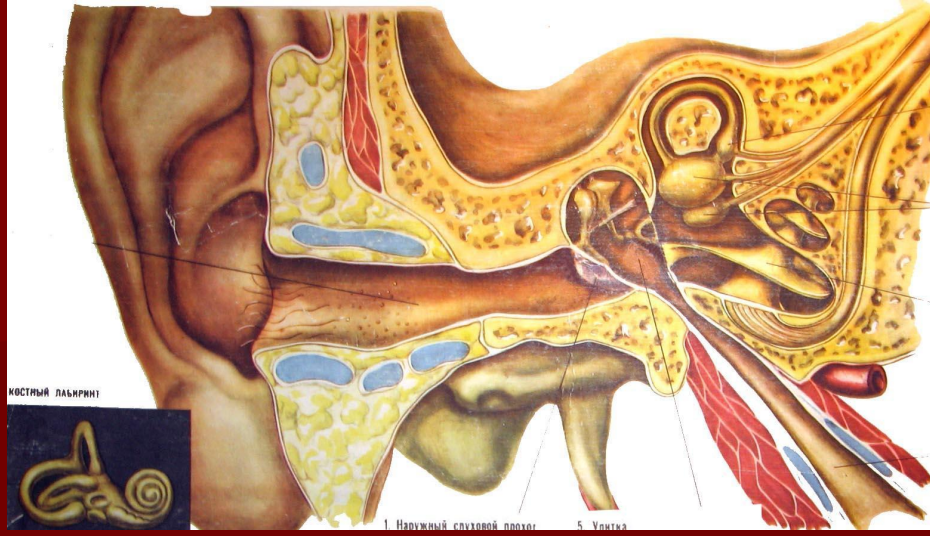
Clinical anatomy, physiology and methods of examination of the middle ear.

The contemporary methods of examination of the cochlear apparatus. Acute middle otitis. The peculiarities of acute otitis

in children. Kinds of mastoiditis, clinical symptoms, diagnosis, treatment.

Actuality of the theme.



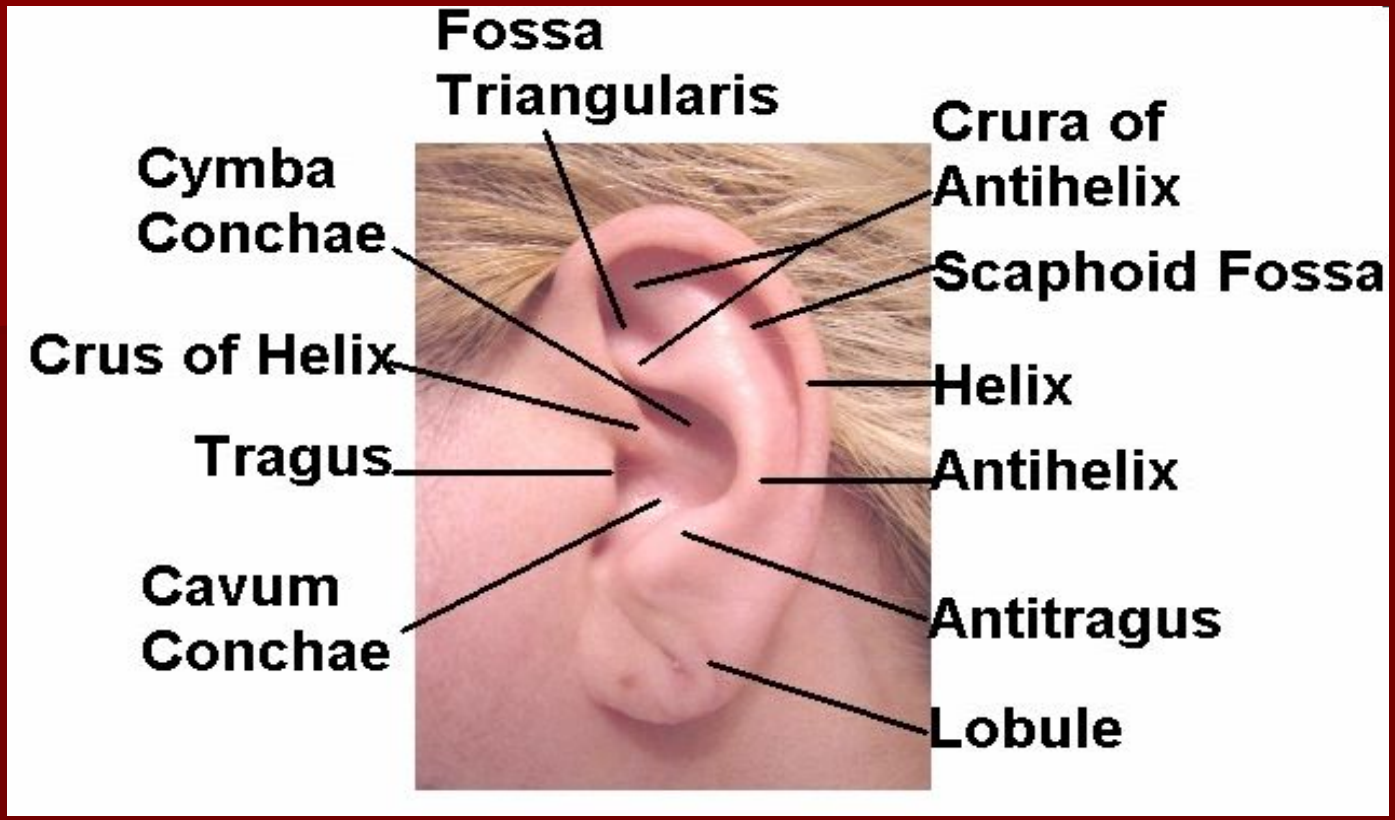
Acoustic analysator is of importance in process cognition of surrounding world, is assist to forming speech function.

Diseases of the ear, the breach acoustic function are one of the most frequent pathology; the fall of ear and deafness are reflected on the capacity for work, on its condition.

Inflammatory diseases of the ear can be the reason of the heavy lively dangerous intracranial complications.

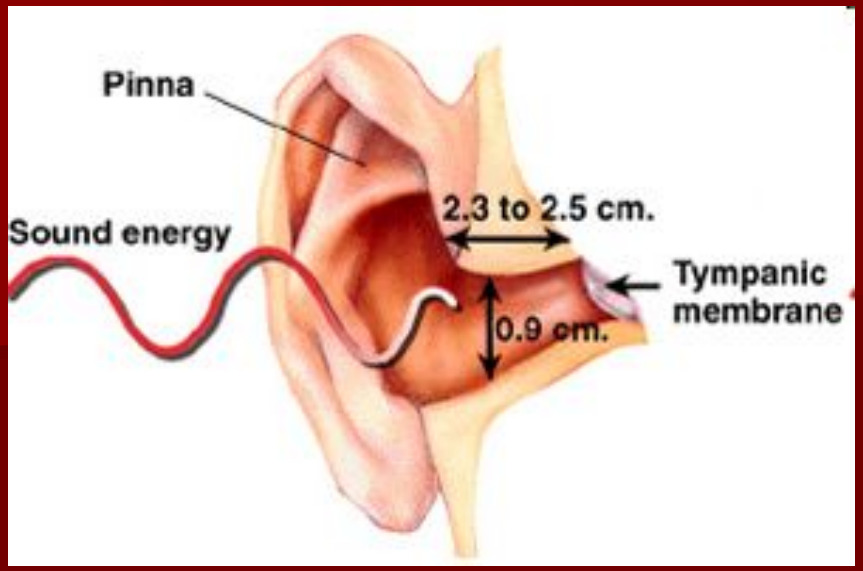
External and middle ear

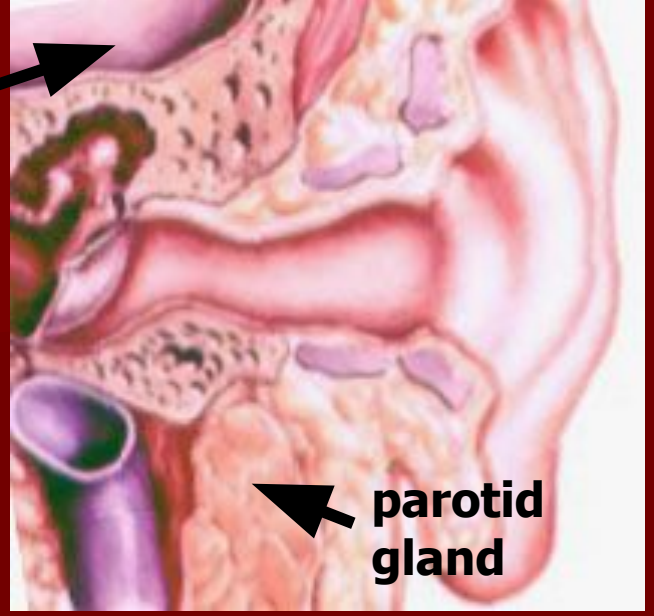
Organ of hearing in anatomical relations is divided into three parts: external, middle and internal ear; functionally into - sound conducting and sound apprehensive apparatus. The auricle, external auditory tube passage, which gather sound waves, tympanic membrane, chain of ossicle bones and perilympha of internal ear belong to the sound conduction apparatus.


Fossa Triangularis
Crura of Antihelix
Cymba Conchae
Scaphoid Fossa
Crus of Helix
Helix
Tragus
Antihelix
Cavum Conchae
Antitragus
Lobule

The *external auditory meatus* extends from the funnel-shaped hollow on the outer surface of the pinna to the tympanic membrane end of the canal separates the external and the middle ears. The outer third of the auditory canal consists of cartilage and membranous tissue, and both inner portions of bone.

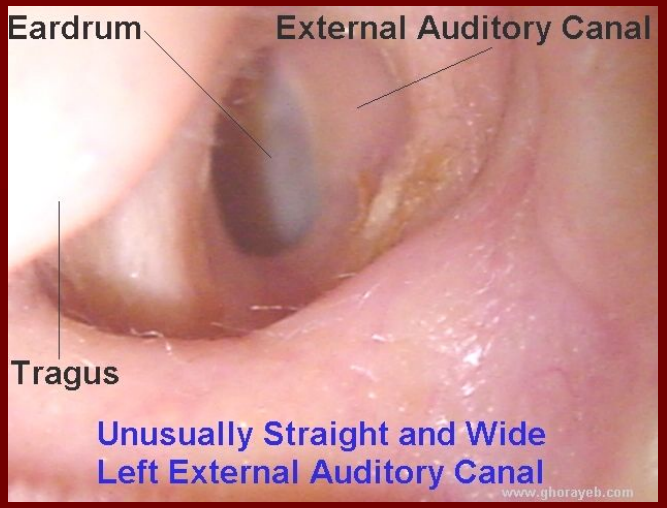
Its narrowest part is the isthmus, where the cartilaginous and bony portions form a junction and where foreign bodies are most likely to lodge. The skin covering the cartilaginous portion abounds in hair, sebaceous glands and ceruminous glands which secrete the earwax, or cerumen. The skin of the bony portion has neither hair, nor glands.





; The external bony meatus has four walls: the *superior* wall formed by the squamous portion of the temporal bone, its internal part bordering on the floor of the middle cranial fossa; the *posterior* wall serving as the front wall of the mastoid process

The anterior wall adjoins the articular head of the mandible, which explains why it is painful to open the mouth and chew in cases of inflammation of the anterior wall of the external auditory meatus.



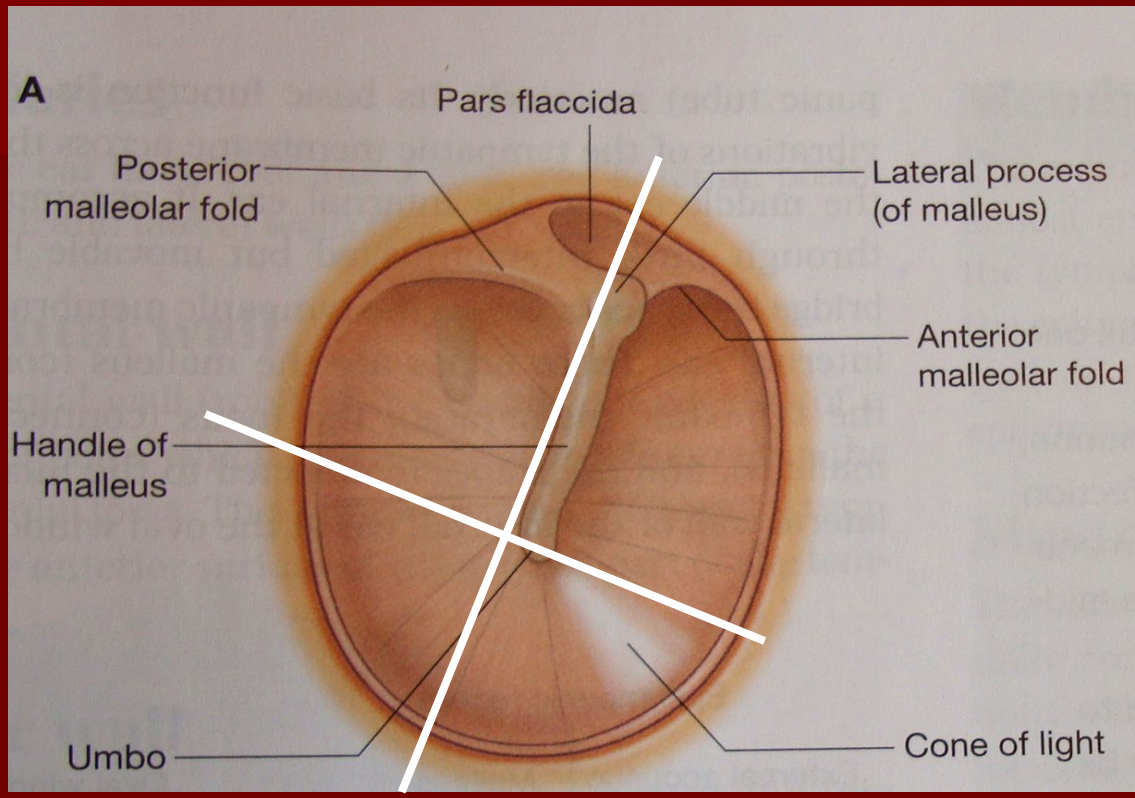
In the newborn, there is neither bony auditory meatus, nor mastoid process, and in place of the former there is a bony ring or *annulus,* which is deficient in a small upper section, and is directly connected with the membranocartilaginous auditory meatus. By the end of the third year the external auditory meatus is fully developed.

The external ear is supplied with blood by branches of the external carotid artery. It is innervated, in addition to the trigeminal branches, by the auricular nerve *(ramus auricularis n. vagi)* in the posterior wall of the auditory meatus.

Mechanical irritation of the latter wall, as in wax removal, often causes reflex cough. The lymph from the walls of the auditory meatus drains into the nearest lymph nodes located in front of the auricle, on the mastoid process, and under the inferior wall of the auditory meatus.

Tympanic Membrane

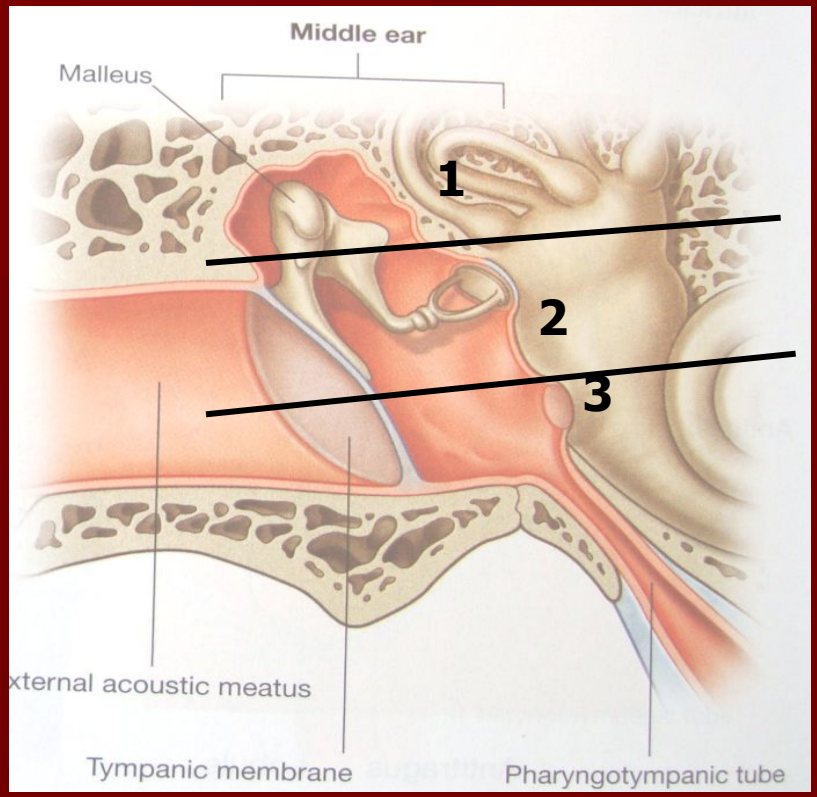
The tympanic membrane or drum between the external and middle ear. The greater part of the drum is called the *pars tensa; ,*



smaller part of the pars *flaccida* or *Shrapnell's membrane.*

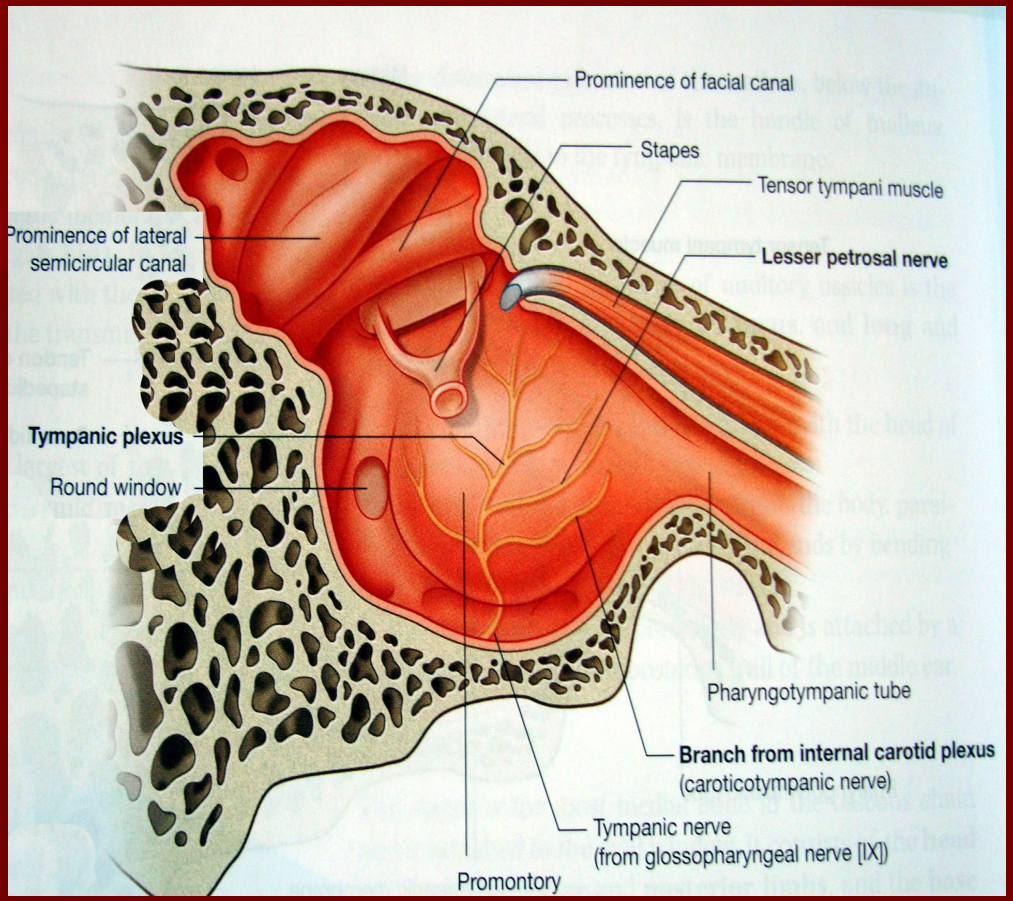
The drum consists of three layers: an outer or epidermal layer continuous with that of the auditory meatus, a middle layer of radiating and circular connective tissue fibres, and an inner layer of mucosa continuous with the mucous membrane of the tympanic cavity. Shrapnell's membrane or pars flaccida consists only of two layers and lacks the middle stratum of fibrous tissue.

The middle ear comprises the tympanic cavity, the mastoid process with its cellular system and the Eustachian tube, all directly interconnected.

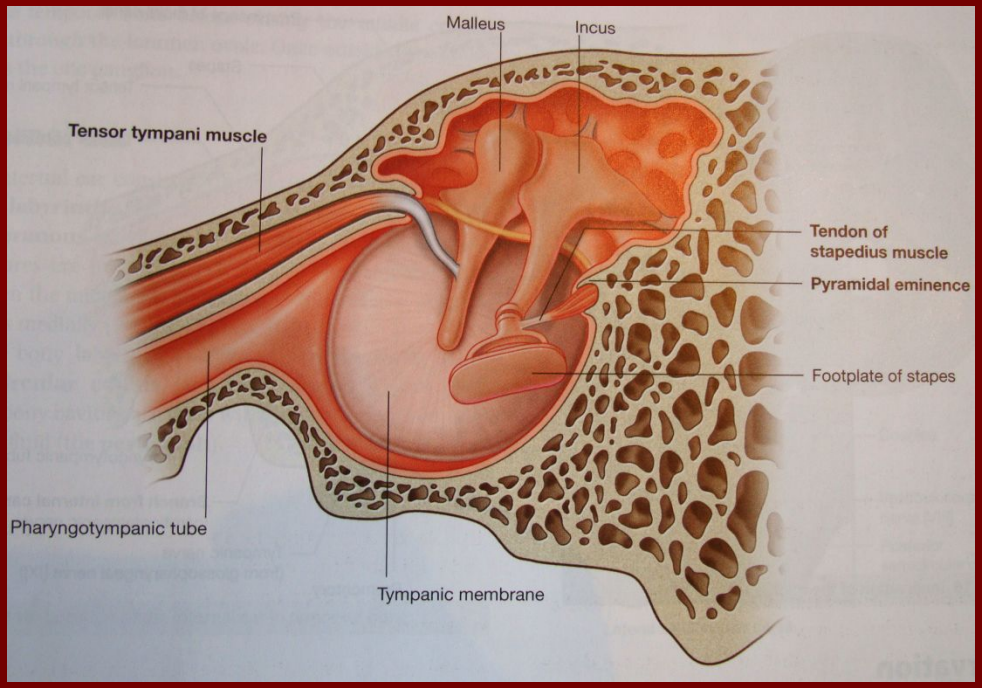


It is customary to divide the tympanic cavity into three parts: the middle and biggest part, *mesotympanum(2),* corresponding to the pars tensa of the drum; the upper part, *epitympanum(1),* lying above the former and also known as the epitympanic recess or attic; the lower part, *hypotympanum(3),* lying below the drum level

An opening in the upper part of the *posterior wall* leads to the mastoid antrum *(aditus ad antrum mastotdeum).* The *internal wall* separates the tympanic cavity from the internal ear.

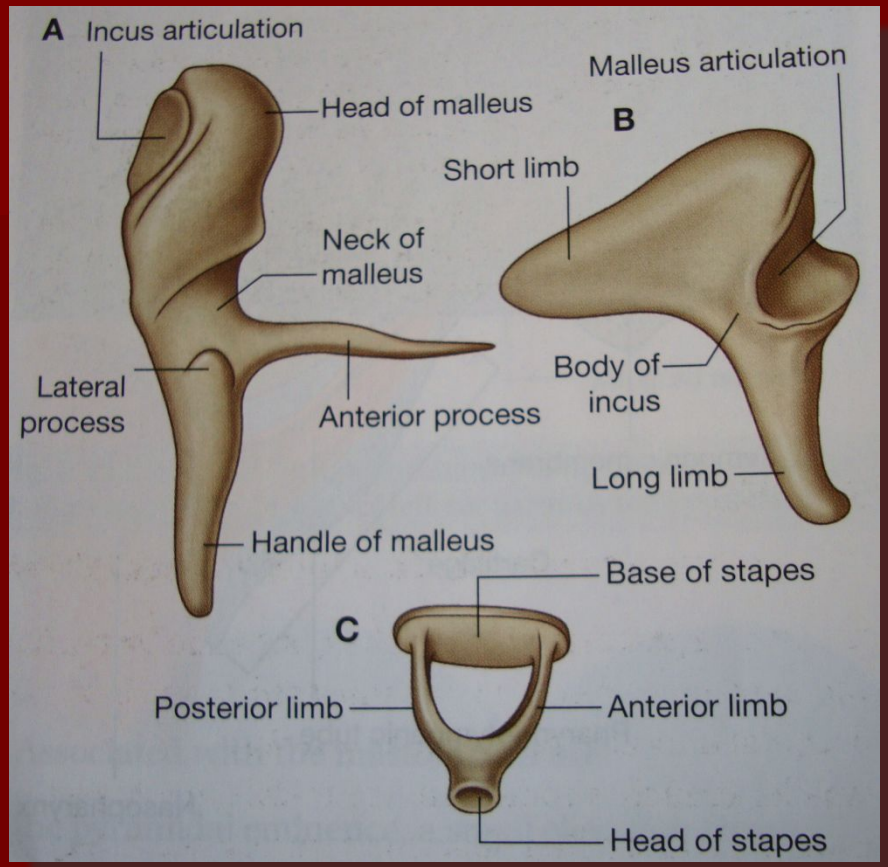


On reaching the entrance to the antrum, the facial nerve canal turns downwards to form a descending knee, then passes behind the posterior wall of the auditory meatus and through the stylomastoid foramen to the base of the skull.

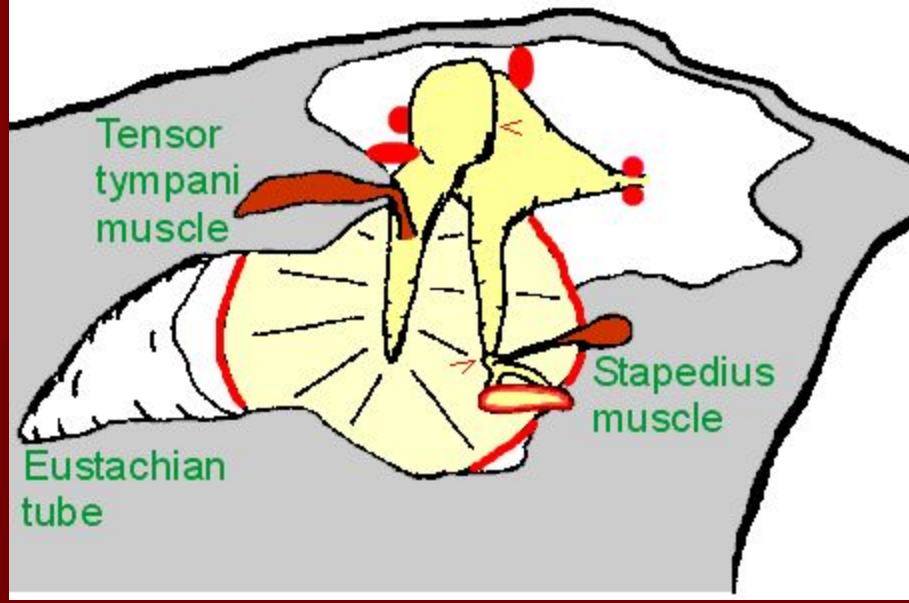


This sometimes causes the development of facial paresis and paralysis in suppurative otitis media. The *external wall* of the tympanic cavity is formed by the tympanic membrane, and above the drum by the external bony wall of the epitympanic recess or attic.

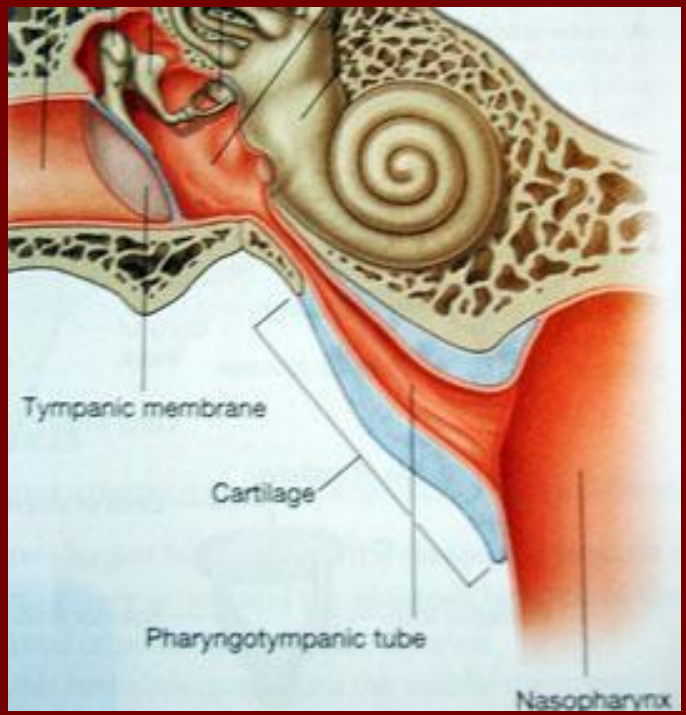
The tympanic cavity contains the three auditory ossicles the malleus, the incus and the stapes which are interconnected by joints and ligaments to form a continuous and rather flexible chain between the drum and the oval window.



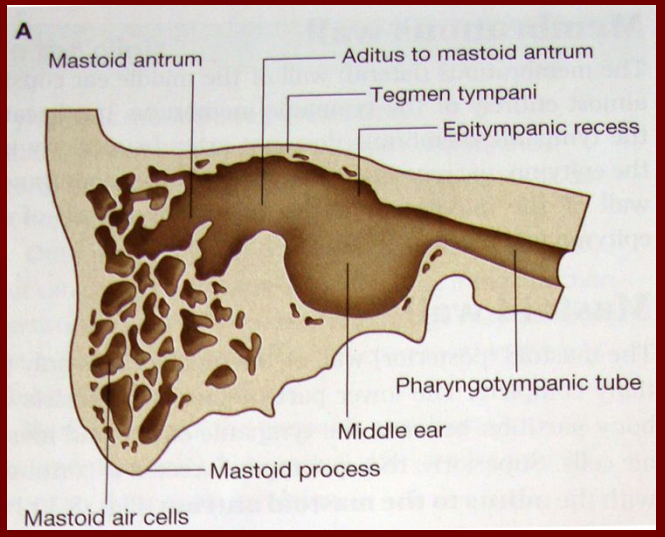
The *tympanic muscles.* There are two muscles in the tympanic cavity: The *tensor tympani* muscle which stretches the tympanic membrane. The *stapedius* muscle which arises from the posterior wall of the tympanic cavity and is attached to the head of the stapes by a slender tendon.



Eustachian or *auditory tube* which is about 3.5 cm in length connects the tympanic cavity with the nasopharynx.



The *mastoid process* located just behind the external auditory meatus is a bony structure protruding downwards with the sternocleidomastoid muscle attached to it. In young children, the mastoid process is not fully developed and represents a bony tubercle behind the osseous tympanic ring.



The *anterior wall* of the mastoid process is the posterior bony wall of the external auditory meatus. The *internal wall* of the mastoid process abuts upon the labyrinth, and more posteriorly is bordered by the postcranial fossa. On the surface facing the post-cranial fossa there is a rather wide S-shaped groove, the sigmoid sulcus, containing part of the sigmoid sinus of the dura mater. The central part of the mastoid process is the antrum lying just behind the epitympanic recess.

The antrum communicates with the tympanic cavity and the air-filled cells of the mastoid process. The superior wall or roof of the antrum separates it from the middle cranial fossa.

The following types of structure are to be found in the mastoid process: the **pneumatic** or large-celled, the **diploic** and the compact or "**sclerotic**". In the case of pneumatic structures, the cavity of the mastoid process is divided by thin bony partitions into a lattice of larger and smaller cells.

In compact structures the bone is indurated and the cells are very few; this structure frequently occurs as a result of chronic suppurative otitis media

Man can hear external sounds with a frequency of 16 to 20,000 cycles per second. Speeching diapason of hearing is from 500 to 4000 Hz. It is usually measured in decibles. At a distance of one metre, intensity of whisper=30 dB, normal conversation= 60dB, shout = 90 dB, discomfort of the ear = 120 dB.

Methods of examination.

Hearing test (whispered and spoken voice tests).

1. The patient is at a distance of 6 metres from the examiner, with the examined ear toward the physician
2. The patient is asked to repeat loudly the words uttered by the physician. In order to prevent visual hearing (lipreading), the patient should not look at the physician.
3. The physician exhales normally, and then whispers words with low vowels, e. g. "hawl, raw", etc., and then with high vowels, such as "feet, cheese", etc.
4. If the patient cannot hear at a distance of 6 metres, the physician should approach the patient to a distance of 5 metres, and examine the patient again.

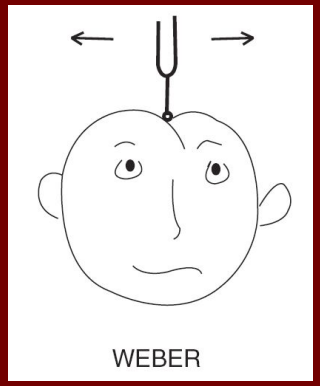
The distance should thus be shortened by 1 metre each time until the patient repeats correctly all the words pronounced by the physician.

5. The results of the test are expressed in metres at which the examinee hears the whispered words.
6. The patient can be tested for hearing spoken voice using the same technique as in the whispered voice testing.

Tuning-fork tests.

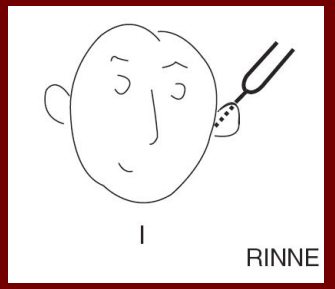
Test for air conduction. A set of tuning forks (Ci28, C512, C2048) is used for the purpose. The test begins with the lower frequency (C128).

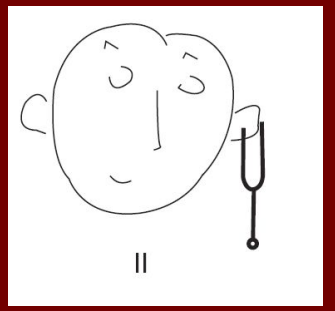
Weber's test. A vibrating fork (C128) is placed on the vertex of the patient's head so that the stem of the fork is in the midline of the head.



Normally the patient hears the tuning fork in the middle of the head, i. e. by both ears. If the sound is heard better by the affected ear, the conduction system is probably damaged. If the sound is better heard by the normal ear, this is probably due to disease of the auditory apparatus.

Rinne's test A vibrating tuning fork (C128) is placed with its stem on the mastoid. After the patient reports discontinuation of sound perception, the fork (without reactivation) is put to the external acoustic meatus. If the patient hears the fork sound through air, the Rinne test is considered positive *(+).* If the patient does not hear the fork through the external





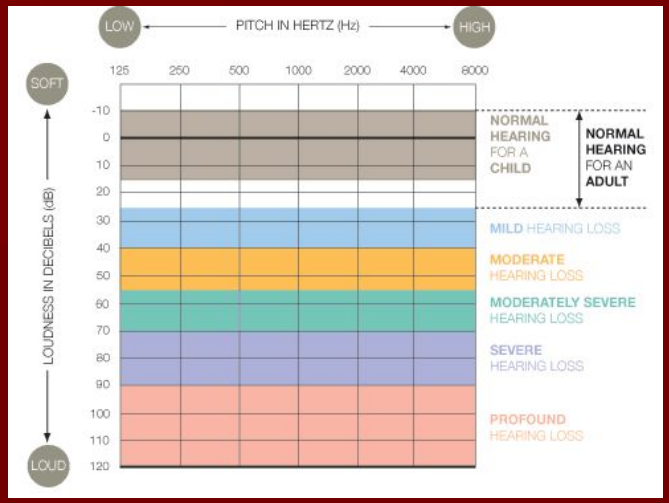
Federici's test. C128 tuning forks are used. A vibrating fork is applied to the mastoid process. As the patient hears it no longer, the fork is placed on the tragus.

Pure tone audiometry.

If the investigation by speech and turning forks not

The term "audiometry" means the methods of investigation the ear with the help of electroacoustic apparatus - audiometer.

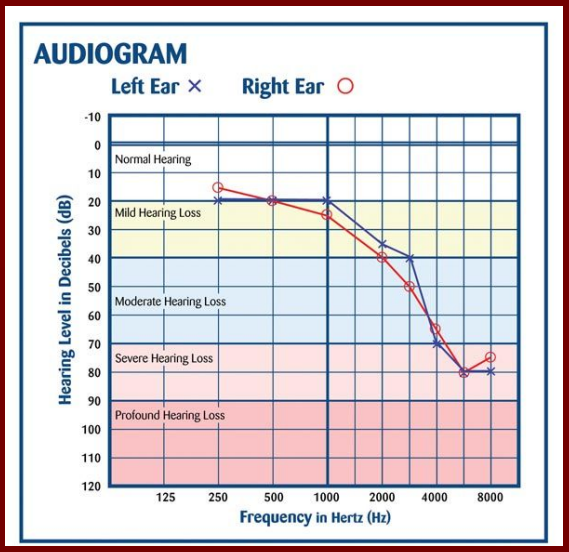
An audiometer is an electronic device which produces pure tones, the intensity of which can be increased or decreased in 5 dB steps. Usually air conduction thresholds are measured for tones of 125,250,500,1000,2000,4000 and 8000 Hz and bone conduction thresholds for 250,500,1000and2000and 4000 Hz.

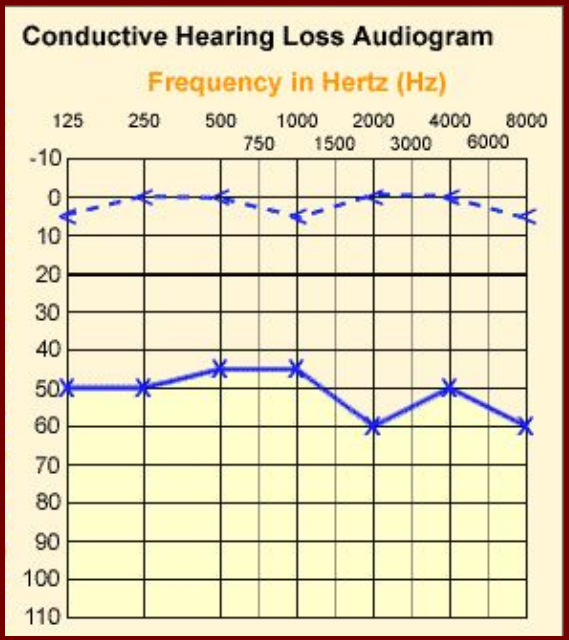


Maximum intensification of the sound by investigation ear conductivity 60-80 DB. The investigation is accompanied in special soundsolate chamber. It is charted in the form a graph called *audiogram.* On scale of audiometer the level of normal (according international standart) ear correspond to line 0Db, that is loss of ear on this level is 0. The threshold of bone conduction is a measure of cochlear function. The difference in the thresholds of air and bone conduction is a measure of degree of conductive deafness.

Pure tone audiogram is a measure of threshold of hearing by air and bone conduction

The presence on the audiogramm bone-ear break always testify about the defeat soundconducting apparatus which can go with the defeat soundperceiving apparatus.





ACUTE OTITIS.

Acute purulent middle otitis is called inflammatory infectious disease of mucous layer of air containing cavities of middle ear. Today acute middle otitis occurs quite frequently within the population of different age groups and particularly frequent in early child age due to anatomic peculiarities of structure of middle ear in this age, as well as tendency towards infectious diseases, which are complicated by diseases of ear.

Suffered acute otitis may be the reason of stable hard hearing, of development of chronic inflammation of middle ear, threatening intracranial complications. Probability of the latter is related with no diagnosis at right time, as well as with mistakes in treatment tactics of acute purulent middle otitis

The direct cause of acute otitis media is infection of the middle ear with streptococci, staphylococci, pneumococci, and less frequently other microbes; mixed flora is sometimes responsible for the onset of the disease.

Acute otitis is often secondary. It can be a complication or a manifestation of a systemic infection, for example, infection of the upper airways and influenza; scarlet fever, measles, and some other diseases provoke acute otitis media in children. It can be due to acute and chronic inflammation of the pharynx and the nose. The main pathological factor is mechanical compression of the pharyngeal orifice of the auditory tube and impairment of its ventilating and draining functions. Among such diseases are adenoids, polyps of the nose, tumors of the pharynx. Less frequently otitis is

Infection usually enters the middle ear through the auditory tube. Less frequently infection gets into the middle ear through an injured tympanic membrane or through the damaged mastoid process. In rare cases infection penetrates into the middle ear by haematogenic routes (in infectious diseases).

Three periods are distinguished in a typical course of acute suppurative otitis media.

The **first** period is characterized by the onset and development of inflammation in the middle ear, infiltration and exudation, and development of minor symptoms, such as hearing loss, noise, earache, hyperemia of the tympanic membrane, protrusion of the membrane due to the thrust of the exudate, and some general symptoms such as elevation of body temperature to 38-39 °

The second period is perforation of the tympanic membrane and discharge of pus. All reactions subside. Otopyorrhoea lasts 4-7 days. Perforation of the tympanic membrane sharply changes the course of acute otitis: earache subsides and disappears, temperature normalizes quickly, palpation of the mastoid process becomes less painful, and the general condition of the patient improves.

Inflammation subsides in the third period. Purulent discharge discontinues, perforation closes, and the anatomical and functional condition of the middle ear is restored.

The **first** period of acute otitis media can sometimes be very grave and attended with hyperpyrexia, severe headache, vomiting, vertigo, and drastic impairment of the general condition, painful palpation of the mastoid process. Changes in the blood of patients with otitis during the first days of the disease are characterized by high leukocyte count with a considerable shift to the left. After perforation of the tympanic membrane and discharge of pus, the blood picture gradually normalizes. If the disease runs a typical benign course, the patient usually recovers with resolution of the inflammation and complete restoration of the hearing function. If the disease runs an atypical course, the outcomes can be different, with adhesions and commissures between the tympanic membrane and the medial wall of the middle ear and impairs hearing (adhesive otitis media); persistent dry perforation (dry perforating otitis media); **conversion** of acute disease into its chronic form with persistent perforation and periodic otopyorrhoea; **complications** such as mastoiditis, labyrinthitis, paresis of

Dynamics of basic symptoms of AMO in 3 stages of development of process

Symptoms	I stage (before-perforate)	II stage (perforation or pus flow)	III stage (scaring or healing)
Pain in ear	sharp	insignificant	absent
Noise in ear	moderate	less expressed	absent
Decrease in hearing	sharply	decreased	restores
Excretions	no	serous-blood, mucous-purulent	stops
Changes in tympanic membrane	infiltrated, hyperemised, protruded	perforation, pulsate reflex	tympanic membrane becomes distinct, appear recognising points (signs), at the beginning short process of malleus and at the end - light cone; scars of perforation of tympanic membrane
Temperature of body	high	subfebril	normal

Differentiate symptoms of AMO from external otitis.

Symptoms	AMO	External otitis
Pain in ear	Sharp, pulsate, irradiate; accompanied with head ache, heaviness and pressure in ear	Strong, sometimes irradiate, not accompanied by headache; increases during chewing, movement of jaw
Decrease of hearing	Moderate	Hearing is not changed
Noise in ear	Of sharp intensity	Absent. May arise during sharp infiltration of skin of auditory passage and its felling with pus
Character of excretion in acoustic meatus (auditory passage)	Mucous-purulent, serous; blood.	Purulent
Touching of acoustic meatus and tragus	Painless	Sharply painful
Change in tympanic membrane	Depending upon stage of process	Unchanged

Treatment includes sparing conditions at home or at hospital. The in vitamins to ensure the normal function diet should be easily and rich of the gastrointestinal tract. Vasoconstrictors or astringents should be instilled into the nose for restoration or improvement of ventilation and drainage of the auditory tube (naphtyzini, halasolini, sanorini) In cases of shooting pains and marked redness of the drum,sp… drops should be used. If acute otitis media runs a severe course with marked general and local symptoms, antibiotic is injected intramuscularly for at least 5-6 days. Analgesics and antipyretics should be given for severe headache and pyrexia. Warming compresses should be placed on the mastoid process. Compresses should be prepared as follows: gauze should be folded four or five times and soaked in alcohol diluted with water (1:1). The compress should be changed at

In rare cases, when this treatment fails and severe pain in the ear persists, the body temperature remains high and the tympanic membrane bulges outside, it is necessary to incise the tympanic membrane. Paracentesis is positively indicated for irritation of the middle ear or meningeal irritation which are manifested by vomiting, vertigo, severe headache, and other signs. Paracentesis is more frequently indicated for children because their tympanic membrane is thicker (especially in nursing infants) and it resists rupture stronger than in adults, while the local and general symptoms (pain, pyrexia) are more pronounce

Paracentesis. The tympanic membrane is incised using a special needle and observing the rules of asepsis. When performing paracentesis in children, not only the head but the whole body must be immobilized. The incision is made on the drum bulge, welllit, kept under direct observation and carried downwards in the posterior-inferior quadrant of the

Special conditions must be provided for unobstructed drainage of pus from the ear after paracentesis. This can be attained by inserting a special turunda. The external acoustic meatus must be cleaned thoroughly using sterile hygroscopic cotton with 3% hydrogen peroxide. The ear may be syringed once or twice daily under low pressure along the posterior wall of the auditory meatus. After them the medicinal preparations can be administered into the middle ear through the external acoustic meatus (transtympanic administration).To that end, the mentioned mixture (1 ml) should be instilled into the acoustic meatus and forced into the tympanic cavity by gently pressing the tragus into the external orifice of the acoustic meatus. The medicinal solution can pass the middle ear, the auditory tube, and enter the mouth and nose. The blowing with balloon of Politcer, catheterisation of the auditory tube

Moreover, this procedure normalizes the function of the auditory tube and has a favorable effect on the course of inflammation. Blowing through a catheter is effective during the third stages of acute otitis media. The procedure should be performed once a day, during 3 or 4 days. A suspension of hydrocortisone mixed with antibiotics should be administered into the middle ear through a catheter.

Prevention includes a combination of measures such as control of infectious diseases, timely treatment of acute and chronic diseases of the nose, paranasal sinuses, and the nasopharynx.

Acute otitis media in children. Acute otitis media in neonates and infants occurs much more frequently than in adults. Its course is specific. The special character of the symptoms is determined by the absence of

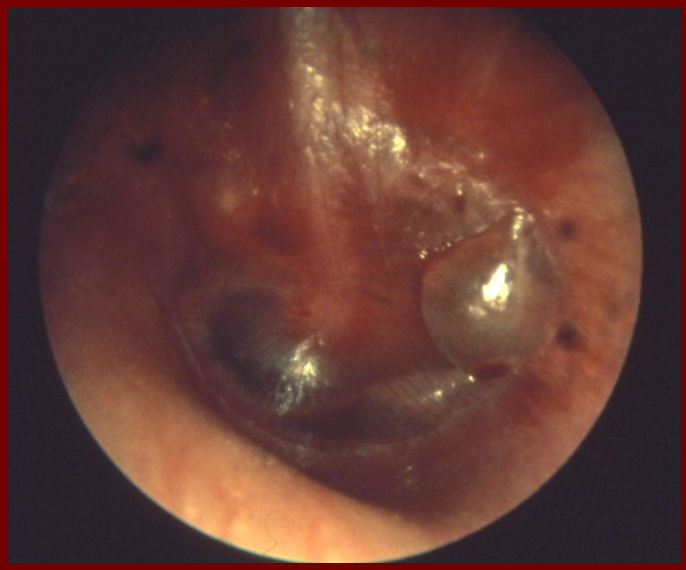
Inflammation of the middle ear in neonates often develops due to penetration of amniotic fluid into the middle ear through the auditory tube during birth. The infection mechanism in nursing infants is the same, but in addition to infection penetrating from the nose and nasopharynx, food can also pass into the middle ear during regurgitation.

It is more difficult to establish the *diagnosis* of acute otitis media in a nursing infant. But the behavior of a baby with a diseased ear differs substantially from that of a healthy baby. The baby has bouts of inconsolable crying, refuses the breast because of pain during swallowing, rubs his diseased ear against the mother's hand. The main symptoms of the disease are painful palpation of the tragus (because of the absence of the bony part of the acoustic meatus) and high body temperature (39.5-40°C). A baby with otitis media is almost always depressed and sleeps a lot; his gastrointestinal function is upset; vomiting develops and wasting ensues. Meningeal symptoms with dimmed consciousness are possible.

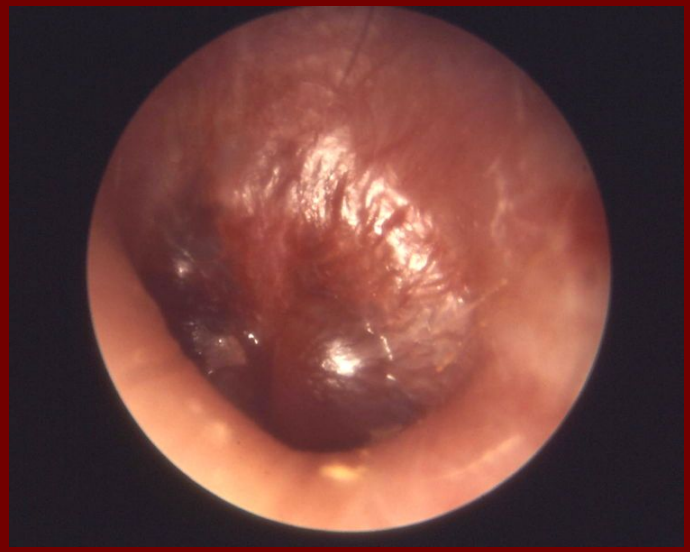
Influenzal otitis occurs usually during viral influenza epidemics. The virus penetrates directly into the ear by the haematogenic route or from the upper airways through the auditory tube.

Specific influenzal otitis is characterized by haemorrhagic inflammation which is manifested by a pronounced dilatation of the vessels in the external acoustic meatus and the middle ear with extravasation (haemorrhage) under the epidermis in the bony part of the external acoustic meatus and the tympanic membrane.

Extravasation appears as haemorrhagic blisters (bullae) in the mucous membrane of the middle ear.



- Influenzal otitis is localized mainly in the supratympanic space. **Its course is often very severe, because inflammation develops in the presence of general toxemia, sometimes with involvement of the internal ear.**



Treatment includes measures directed at eradication of the main disease and its local manifestations. Timely and correct use of antibiotics for scarlet fever and measles has reduced significantly the incidence of purulent

Acute mastoiditis is a complication of acute otitis media. This is inflammation of the bony tissue of the mastoid process which occurs in malignant course of acute suppurative otitis media. The inflammation easily extends from the tympanic cavity onto the cells of the mastoid process through the entrance to the antrum due to the high virulence of the microbes.

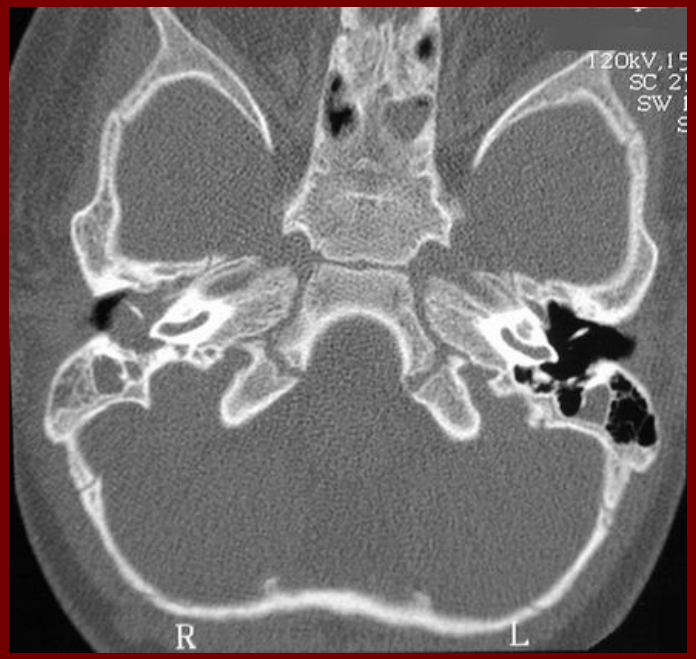
Incorrect use of antibiotics therapy for acute otitis and also unreasoned abstention from paracentesis, blowing of tube auditive can cause secondary mastoiditis. Changes in the mastoid process associated with typical mastoiditis vary depending on the stage of the disease. **Mucoperiostal** (I) and **bone-alterative** (II) stages of mastoiditis

Symptoms. The clinical signs of mastoiditis can be local and general. The general symptoms are impairment of the patient's general condition, fever, changes in the blood, etc. They do not differ substantially from those of acute suppurative otitis media. The subjective symptoms are pain, noise in the ears, and hearing loss. Examination of a typical mastoiditis patient reveals hyperaemia and infiltration in the skin overlying the mastoid process (due to periostitis). The pinna is displaced either anteriorly or inferiorly. The mastoid process, especially the apex, and sometimes its posterior margin, are very tender to palpation. Inflammation in the mastoid process can be activized causing subperiosteal abscess due to passage of pus from the mastoid cells to the periosteum. The

The specific otoscopic symptom of mastoiditis is sagging soft tissue of the posterior-superior wall of the bony part of the external acoustic meatus at the tympanic membrane (the anterior wall of the antrum). Otopyorrhoea is often pulsating and profuse. The consistency of pus is often creamy. Pus can fill the acoustic meatus immediately after its cleaning.

Diagnosis. Roentgenography of the temporal bone is very important for diagnosis. An X-ray picture shows diffuse reduction of pneumatization and shaded antrum and the cells.

During later stages of the disease the bony septa can be destroyed with formation of clear sites on X-ray pictures (due to destruction of bone and accumulation of pus).



Treatment. Depending on the stage of acute otitis media and mastoiditis. Conservative treatment includes administration of antibiotics (locally and intramuscularly). The patient should first be tested for sensitivity to these preparations. The condition of the nose, the paranasal sinuses and the nasopharynx should be thoroughly examined in each particular case, especially in children. If conservative treatment fails, objective symptoms intensify, and complications develop in the areas adjacent to the middle ear, surgical intervention is necessary.

Basic differential diagnostic symptoms of AMO and mastoiditis

Symptoms	AMO	Mastoiditis
General (overall) condition	Improves	Inspite of treatment deteriorates
Pain in ear	After perforation decreases	Inspite of perforation does not decrease
Noise in ear	Gradually decreases	In spite of treatment does not decrease
Hearing	Improves	Does not improve
Excretion from ear	Stands less, after then disappears. From serous - blood and mucoid-purulent stands mucoid	Purulent; purulent-blood in very big quantities
Palpation of mastoid process	Painless, may be painful during the first days of disease (mastoidal reaction)	Sharply painful
Skin of postauricular region	Unchanged	Infiltrated, swollen mastoid process, smoothness of postauricular fold
Change in tympanic membrane and external acoustic meatus	Correlative to stages	Infiltrated, thickened (mastoidal type); hanging of posterio-superior wall of acoustic meatus
Percussion of mastoid process	Painless	Painful

Differentiative symptoms of mastoiditis and furuncul of external acoustic meatus

Symptoms	Furuncul of external acoustic meatus	Acute mastoiditis
Spontaneous pain	Increase during chewing (mastication)	Does not increase while chewing (mastication)
Pain caused by pressing	Maximum while pressing on tragus	Maximum while pressing on mastoid process
Pain cased by pulling the auricle	Extremely painful	Painless
Condition of external acoustic meatus	Swelling of skin of cartilaginous part	Swelling of bony part (hanging of posterior wall)
Tympanic membrane	Normal	Changed
Hearing	Normal	Decreased
Temperature	Normal or slightly increased	Increased nearly always

The operation on the mastoid process, known as mastoidectomy, is performed under local and sometimes under general anesthesia.The operation is usually concluded by filling the wound with antibiotic powder and packing it lightly with tampons. Sometimes mastoid cavity is thoroughly irrigated with saline to remove bone dust and the wound closed in two layers. A rubber drain may be left at the lower end of incision for 24-48 hours in cases of infection or excessive bleeding. Antibiotics started preoperatively are continued postoperatively for at least one week. Culture swab taken from the mastoid