Anatomy of the Ear

Please view our Editing File before studying this lecture to check for any changes.
Objectives

By the end of the lecture the student should be able to:

✓ List the parts of the ear: External, Middle (tympanic cavity) and Internal (labyrinth).

✓ Describe the parts of the external ear: auricle and external auditory meatus.

✓ Identify the boundaries of the middle ear: roof, floor and four walls (anterior, posterior, medial and lateral).

✓ Define the contents of the tympanic cavity:
  I. Ear ossicles, (malleus, incus and stapes)
  II. Muscles, (tensor tympani and stapedius).
  III. Nerves (branches of facial and glossopharyngeal).

✓ List the parts of the inner ear, bony part filled with perilymph (Cochlea, vestibule and semicircular canals), in which is suspended the membranous part that filled with endolymph).

✓ List the organs of hearing and equilibrium.
External Ear

- It is formed of the **auricle** & the **external auditory meatus**.
- The Auricle has a characteristic shape and collects **air vibrations** reception of sound.
- It consists of a thin plate of **elastic cartilage** covered by a double layer of skin.
- It receives the insertion of **extrinsic muscles***, which are supplied by the **facial nerve**.
- Sensation is carried by **great auricular** (from cervical plexus) & **auriculotemporal** (from mandibular) nerves.

*these muscles are insignificant in humans because they don’t move but are prominent in animals, example: bunnies
External Ear

- The **external auditory canal** is a curved S-shaped tube about 2.5 cm (one inch), that conducts & collects sound waves from the **auricle** to the **tympanic membrane**. Its outer 1/3rd is **elastic cartilage**, while its inner 2/3rds are **bony**.

- It is lined by skin, and its outer 1/3rd is provided with **hairs, sebaceous and Ceruminous Glands**: (modified sweat glands that secrete a yellowish brownish substance called the ear wax).

"يمنع دخول الأتربة والحشرات الصغيرة"
Middle Ear (Tympanic Cavity)

- **Middle ear** is a narrow, oblique, slit-like cavity (air-filled) in the *petrous temporal bone* & lined with mucous membrane.
- It contains the *auditory ossicles* (the ear bones), which transmit the vibrations of the tympanic membrane (eardrum) to the internal ear.
Middle Ear (Tympanic Cavity)

- Communicates **anteriorly** with the *Nasopharynx* through the **Auditory Tube** (also called pharyngotympanic or eustachian tube)**, which extends from the anterior wall *downward, forward, and medially* to the nasopharynx).
- The posterior $\frac{1}{3}$rd of the canal is **bony**, and its anterior $\frac{2}{3}$rd$s$ are **cartilaginous**. (the external ear was the opposite)
- Its function is to **equalize the pressure** on both sides of the ear drum. (normally it is closed but it opens to balance the pressure)

*this is significant clinically because recurrent throat infections can travel to the ear*
Middle Ear (Tympanic Cavity)

The middle ear has:
- **Roof,**
- **Floor,**
- and **4 walls:**
  1. **Anterior,**
  2. **Posterior,**
  3. Lateral, and
  4. **Medial.**
Middle Ear (Tympanic Cavity)

Roof & Floor

- The **Roof** is formed by a thin plate of bone, called **tegmen tympani**, which is part of the *petrous temporal bone*.
- It separates the tympanic cavity from the temporal lobe of the brain.

- The **Floor** is formed by a thin plate of bone, which separates the *middle ear* from the **bulb of the internal jugular vein**.
The anterior wall is formed below by a thin plate of bone that separates tympanic cavity from the internal carotid artery.

There are 2 canals at the upper part of the anterior wall.

- The upper, smaller is the canal for the tensor tympani muscle.
- The lower, larger is for the auditory tube.
The posterior wall has in its:

- **Upper part**: a large, irregular opening, the **aditus to the mastoid antrum** (a cavity behind the middle ear, within mastoid process, it contains air cells)

- **Below**: a small, hollow, conical projection, the **pyramid**, which houses the stapedius muscle and its tendon. (The tendon emerges from the apex of the pyramid.)
Middle Ear (Tympanic Cavity)
Medial Wall

- Greater part of the **medial** wall shows a rounded projection, *(Promontory)* that results from the underlying 1<sup>st</sup> turn of the **cochlea**.
- **Above** and behind the promontory lies the Oval window*(Fenestra Vestibuli)*, which is closed by the base of the stapes.
- **Below** and behind the promontory lies the Round window *(Fenestra Cochleae)*. Which is closed by the secondary tympanic membrane.
- It is formed by the lateral wall of the inner ear.

*also called foramen ovale*
Middle Ear (Tympanic Cavity)

Lateral Wall

- The lateral wall is largely formed by the **tympanic membrane** (it's like a satellite to collect sound).
- The membrane is **obliquely** placed, facing downward, forward, & laterally.
- It is extremely **sensitive to pain**.
- Nerve supply of ear drum:
  - Outer surface:
    1. **Auriculotemporal** nerve.
    2. **Auricular branch** of **vagus**.
  - Inner surface:
    **Tympanic branch** of the **glossopharyngeal** nerve.

The lateral wall is toward the **external ear**
The medial wall is toward the **inner ear**
Middle Ear (Tympanic Cavity)  
Tympanic Membrane

- Normally, it is **concave** laterally, and at the depth of its concavity there is a small depression, “the Umbo” produced by the **tip of the handle of the malleus**.
- When the membrane is illuminated through an otoscope*, the concavity produces a “**Cone of Light**,” which radiates anteriorly and inferiorly from the umbo.
- Most of the of the membrane is tense and is called the **Pars Tensa**.
- A small triangular area on its upper part is slack and called the **Pars Flaccida**.

*Extra

Pars Tensa → tense end  
Pars Flaccida → flaccid which means loose
Middle Ear (Tympanic Cavity)

Auditory Ossicles

- The auditory ossicles are 3:
  1. **Malleus** (hammer),
  2. **Incus** (anvil),
  3. **Stapes** (stirrup).

- They transmit sound waves from *tympanic membrane* to the *perilymph* of the internal ear.
- They are covered by mucous membrane & articulate by **synovial joints**.

* المشاكل في هذه المفاصل لدى كبار السن هي سبب ضعف السمع لدى بعضهم

Extra
Middle Ear (Tympanic Cavity)
Muscles of the Ossicles

**TENSOR TYMPANI**
- **Origin:** Cartilage of the auditory tube and the bony walls of its own canal.
- **Insertion:** into the handle of the malleus.
- **Nerve supply:** Mandibular nerve.
- **Action:** Contracts reflexly in response to loud sounds to limit the excursion of the tympanic membrane.

**STAPEDIUS** (the smallest voluntary muscle)
- **Origin:** Internal walls of the hollow pyramid.
- **Insertion:** The tendon emerges from the apex of the pyramid and is inserted into the neck of the stapes.
- **Nerve supply:** Facial nerve.
- **Action:** Reflexly dampens down the vibrations of the stapes by pulling on the neck of that bone.
Middle Ear (Tympanic Cavity) Nerves

**Tympanic nerve**
- It is a branch of the glossopharyngeal nerve.
- It gives:
  - **Tympanic plexus** on the promontory
  - The tympanic plexus gives the, **Lesser petrosal** nerve which relays in the otic ganglion.
  - It gives secretomotor supply to the parotid gland

*Compare:

<table>
<thead>
<tr>
<th>Lesser petrosal (glossopharyngeal)</th>
<th>Otic ganglion</th>
<th>Supply parotid gland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater petrosal (facial)</td>
<td>Geniculate ganglion</td>
<td>supply Lacrimal, Nasal, and Palatine glands</td>
</tr>
</tbody>
</table>
Middle Ear (Tympanic Cavity)  

Nerves

Facial nerve (VII)

- Enters through the Internal acoustic meatus with the 8th vestibulocochlear nerve.
- It expands to form Geniculate ganglion.
- It passes vertical behind the pyramid.
- It leaves the middle ear through the stylomastoid foramen.
- Branches:
  1. Greater Petrosal nerve.
     - Arises from Geniculate Ganglion.
     - Carries preganglionic parasympathetic to supply: Lacrimal, Nasal, and Palatine glands.
  2. Nerve to Stapedius.
  3. Chorda Tympani:
     - Arises just before the facial nerve exits.

Recall: chorda tympani carries taste fibers. So if there was any damage to this nerve the patient will experience dyspepsia Ex: during ear surgeries
To remember: chorda → chocolate or dates
Internal Ear, Or Labyrinth

- Labyrinth is situated in the petrous part of the temporal bone, medial to the middle ear.
- It consists of:

**Bony labyrinth:**
- A series of bony chambers lined by endosteum.
- They contain a clear fluid, the **perilymph**, in which is suspended the membranous labyrinth.

**Membranous labyrinth:**
- consists of a series of membranous sacs and ducts within the bony labyrinth, it is filled with **endolymph**.

Note:
The middle ear was filled with air, but the inner ear is filled with fluid. In the **bony** labyrinth that fluid is **perilymph** and in the **membranous** labyrinth is it **endolymph**.
Internal Ear (Labyrinth)
Bony Labyrinth

- The bony labyrinth consists of:
  - Cochlea
  - Vestibule
  - Semicircular canals

Cochlea
- Its first turn produces the **promontory** on the medial wall of the tympanic cavity.
- It contains the **cochlear duct** (part of the membranous labyrinth).
Internal Ear (Labyrinth)
Bony Labyrinth

Vestibule
- Is the central part of the bony labyrinth.
- Contains the **utricle** & **saccule** (parts of the membranous labyrinth)
- In the lateral wall of the vestibule are:
  - the **fenestra vestibuli** (oval window), which is **closed by the base of the stapes**, and
  - the **fenestra cochleae** (round window), which is **closed by the secondary tympanic membrane**.

*To remember:*
- oval → vestibuli
- round → cochleae
Internal Ear (Labyrinth)
Bony Labyrinth

**Semicircular Canals**
- Semicircular canals: superior (anterior), posterior & lateral.
- Each canal has a swelling at one end called the **ampulla**.
- The canals open into the vestibule by five **orifices**, one of which is common to two of the canals.
- Lodged within the canals are the **semicircular ducts**.
Internal Ear (Labyrinth)  
Membranous Labyrinth

- The **membranous labyrinth** consists of (Four ducts & Two sacs) which are freely communicate with one another:
  - **Sacs**: **Utricle** & **Saccule** lodged in the bony **vestibule**.
  - **Ducts**: Three **semicircular ducts** lie within the bony **semicircular canals**. (anterior, posterior, lateral)
  - **Cochlear Duct**: lies within the bony **cochlea**.

The cochlear duct divides the bony cavity into
- **Scala Vestibuli** (the perilymph is separated from the middle ear by the **base of the stapes** at the **fenestra vestibuli**)
- **Scala Tympani** (the perilymph is separated from the middle ear by the **secondary tympanic membrane** at the **fenestra cochleae**)

Only on the boys’ slides
Internal Ear (Labyrinth)
Membranous Labyrinth

- Located on the walls of the utricle and saccule are specialized sensory receptors, which are sensitive to the orientation of the head to gravity or other acceleration forces.
- The **utricle**, **saccule** and **semicircular ducts** are concerned with maintenance of **Equilibrium**.

- The highly specialized epithelium on the floor of **cochlear duct** forms the **Spiral organ of Corti** that contains the sensory receptors for **Hearing**.
1. The outer 1/3\(^{rd}\) of the external auditory canal is:
   A- bony
   B- elastic cartilage
   C- fibrous cartilage
   D- hyaline cartilage
   Answer: B

2. The auditory ossicles are found in:
   A- external ear
   B- middle ear
   C- internal ear
   D- labyrinth
   Answer: B

3. The tympanic cavity communicates with the nasopharynx via:
   A- laryngotympanic duct
   B- lacrimal duct
   C- internal acoustic meatus
   D- eustachian tube
   Answer: D

4. The floor of the middle ear separates it from the bulb of:
   A- internal jugular vein
   B- external jugular vein
   C- internal carotid artery
   Answer: A

5. The auditory ossicles articulate by _____ joints:
   A- fibrous.
   B- cartilaginous.
   C- synovial.
   Answer: C

6. Stapedius is inserted into:
   A- handle of the malleus
   B- handle of the stapes
   C- neck of the stapes
   D- neck of the malleus
   Answer: C

7. Utricle & saccule are lodged within the:
   A- cochlea
   B- vestibule
   C- semicircular canal
   D- tympanic cavity
   Answer: B

8. Which of the following is responsible for hearing:
   A- utricle
   B- saccule
   C- semicircular duct
   D- cochlear duct
   Answer: D
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