

## Ear Anatomy

### Auricle

- Anatomy:
  - Elastic cartilage that is covered with thin skin.
  - There are several elevations and depressions (helix, antihelix, curl of helix, concha of auricle, antitragus, etc.)
- Function:
  - The function of the external ear is to collect sound and conduct it to the tympanic membrane via the external acoustic meatus.
- Blood supply:
  - Posterior auricular and superficial temporal arteries.
- Innervation:
  - Great auricular nerve:
    - Supplies the posterior aspect of the lateral surface of the ear (helix, antihelix, and lobule)
  - Auriculotemporal nerve:
    - A branch off of trigeminal nerve CN V<sub>3</sub>
    - Innervates the skin anterior to the external acoustic meatus as well as a portion of the external aspect of the tympanic membrane
- Lymphatic Drainage:
  - The lateral surface of the upper half drains to the superficial parotid lymph nodes
  - The cranial surface of the superior half drains to the mastoid nodes and deep cervical lymph nodes
  - The lower half and lobule drain into the superficial cervical lymph nodes.
- Clinical Application:
  - Auricular Hematoma:
    - Usually occurs as a result of direct trauma to the ear
    - Results in blood forming between the perichondrium and the auricular cartilage
    - Blood accumulation results in distortion of the contours of the ear and can impair blood flow to the cartilage
    - If left untreated, fibrosis can occur leading to deformed architecture (a.k.a., “cauliflower ear” or “boxer’s ear”)
    - Treatment includes aspiration of the blood with a needle to relieve the pressure, removal of clot (if present), and pressure packing to prevent re-accumulation.

### External Acoustic Meatus:

- Anatomy:
  - Approximately 2-3 cm in an adult
  - The medial 2/3 of the canal is bony and lined with thin skin
  - The lateral 1/3 has some ceruminous and sebaceous glands in the subcutaneous tissue that produces cerumen (earwax).
- Function:
  - Transmits collected sounds from the auricle to the tympanic membrane.
- Innervation:
  - Trigeminal nerve (CN V)
  - Vagus nerve (CN X)
- Clinical Application:
  - Otitis Externa:
    - Infection and inflammation of the external auditory meatus [*S. epidermidis* (46%), *S. aureus* (11%), *Pseudomonas* (11%), *Candida* (8%)]
    - Commonly seen in swimmers who do not dry or use ear drops in the meatus after swimming

- Application of pressure or pulling on the auricle usually causes significant pain
- Treatment:
  - First clear the ear canal of any debris and then apply an ear wick if inflammation is present so that the ear drops can be delivered to the entire ear canal
  - Mild cases: acetic acid + propylene glycol + hydrocortisone (Voscol) 5 drops in the ear 3-4 times per day until resolved
  - Moderate to severe: ciprofloxacin + hydrocortisone (CIPRO-HC) 3 drops into the affected ear twice a day x 7 days

### **Tympanic Membrane:**

- Anatomy:
  - A thin, oval semitransparent membrane that is about 1 cm in diameter
  - Divides the external acoustic meatus from the middle ear
  - The malleus is attached to it within the middle ear
- Function:
  - Moves in response to air vibrations that have been transmitted from the external acoustic meatus to the auditory ossicles and then to the inner ear.
- Innervation:
  - External portion of the tympanic membrane:
    - Primarily by the auriculotemporal nerve
    - A small portion is innervated by the auricular branch of the vagus nerve (CN X)
  - Internal portion of the tympanic membrane:
    - Glossopharyngeal nerve (CN IX)
- Clinical Application:
  - Otoscopic Exam:
    - In order to get good visualization of the tympanic membrane, the provider will need to pull on the auricle to straighten out the external auditory canal
    - Infants: pull down and back
    - Adults: pull up and back
    - Upon visualization, the provider should see a semitranslucent membrane and the handle of the malleus in the center of the membrane. Visualization of a light reflex on the inferior aspect is normal in a healthy ear.
  - Otitis Media:
    - An infection involving the middle ear (*S. pneumonia*, *H. influenza*, *M. catarrhalis*, viruses).
    - Results in a red, bulging tympanic membrane (especially if the Eustachian tube is blocked from the inflammation)
    - If left untreated, scarring of the auditory ossicles and/or mastoiditis can occur
  - Tympanic Membrane Rupture:

### **Auditory Ossicles:**

- Anatomy:
  - Malleus
  - Incus
  - Stapes
- Function:
  - Form a mobile chain connecting the tympanic membrane to the oval window.
- Muscles Associated with the Ossicles:
  - Tensor tympani:
    - Attached to the handle of the malleus and pulls it medially to make the tympanic membrane more tense thereby reducing the amplitude of its

oscillations that could lead to damage to the inner ear when hearing loud sounds.

- This muscle is innervated by the mandibular branch of the trigeminal nerve (CN V<sub>3</sub>)
- Stapedius:
  - Attaches to the stapes where it can pull it posteriorly thereby tilting the base of the stapes in the oval window. This will tighten the annular ligament and reduce the oscillatory range.
  - This muscle is innervated by the facial nerve (CN VII)
- Clinical Applications:
  - Paralysis of the Stapedius Muscle:
    - Usually caused by a lesion or mass to the facial nerve
    - Results in the patient experiencing excessive acuteness of hearing called hyperacusis because the movement of the stapes is not being inhibited.

### **Inner Ear:**

- Anatomy:
  - The bony labyrinth is made up of the cochlea, vestibule, and semicircular canal
  - The cochlea is the shell shaped (or spiral shaped) structure that is involved in hearing
- Function:
  - Hearing by transmitting the vibrations into nerve impulses that travel to the brain via the cochlear nerve
  - Provides positional awareness
- Innervation:
  - Vestibulocochlear nerve (CN VIII) which is made up of the cochlear nerve and the vestibular nerve.
- Clinical Application:
  - Meniere Disease:
    - Characterized by hearing loss, vertigo, and tinnitus
    - Caused by blockage of the cochlear aqueduct resulting in an increase in the volume of endolymph
  - Motion Sickness:
    - Characterized by nausea, vomiting, sensation of movement even though the patient is not moving
    - Caused by the otoliths that are embedded in the hair cells of the membranous labyrinth moving around under the influence of gravity. They effectively bend these hairs and thereby stimulate the vestibular nerve to deliver positional information that is not in concordance with the visual inputs to the brain.
  - Sensorineural Hearing Loss:
    - A type of hearing loss resulting from a defect or damage to the cochlea, cochlear nerve, brainstem or connections to the brain's cortex