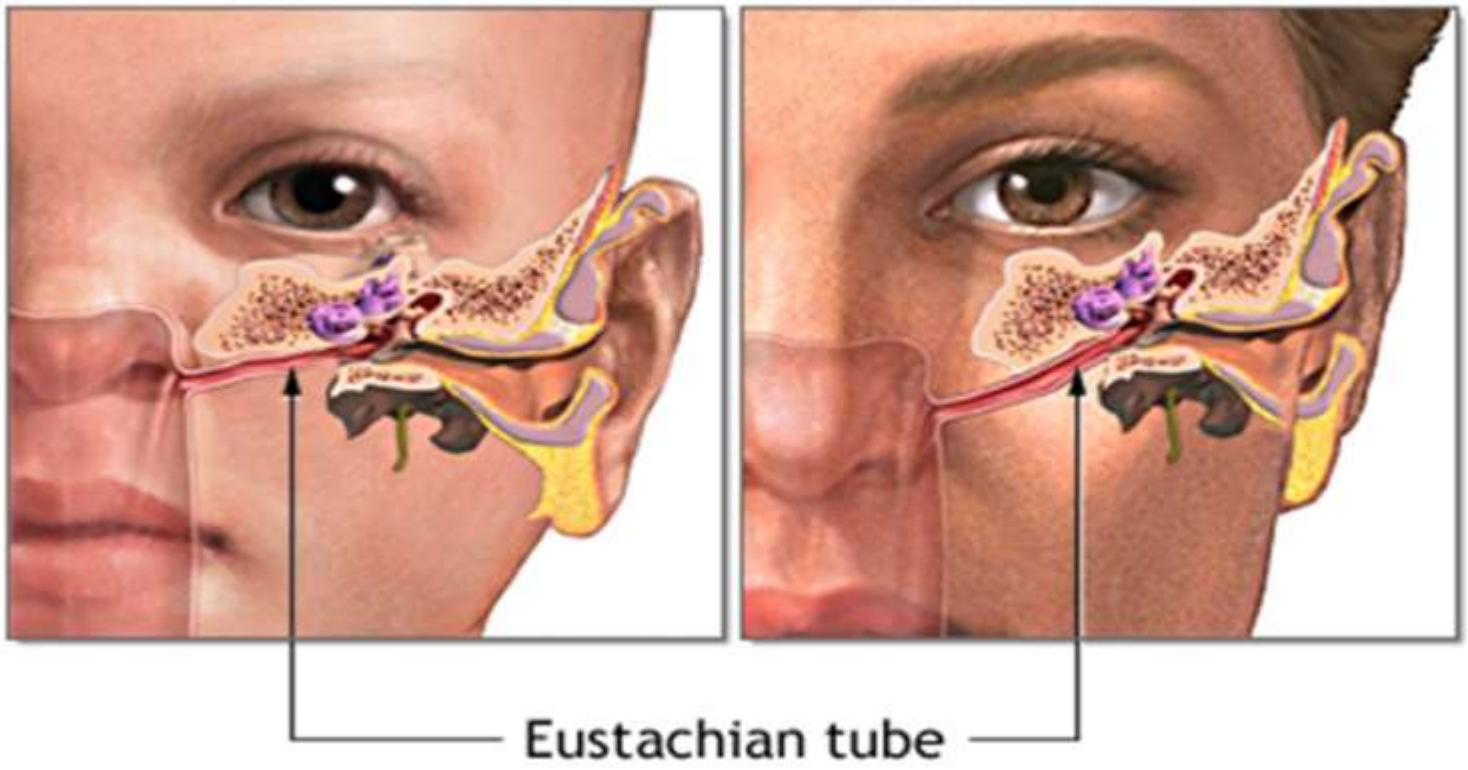
Eustachian Tube And Its Disorders



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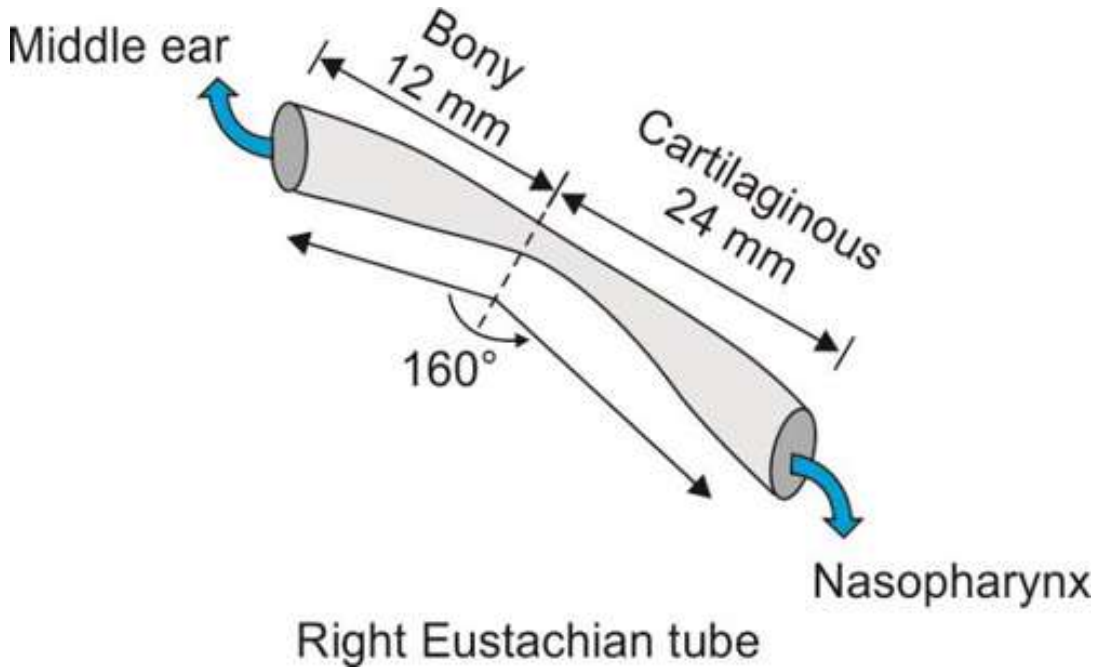
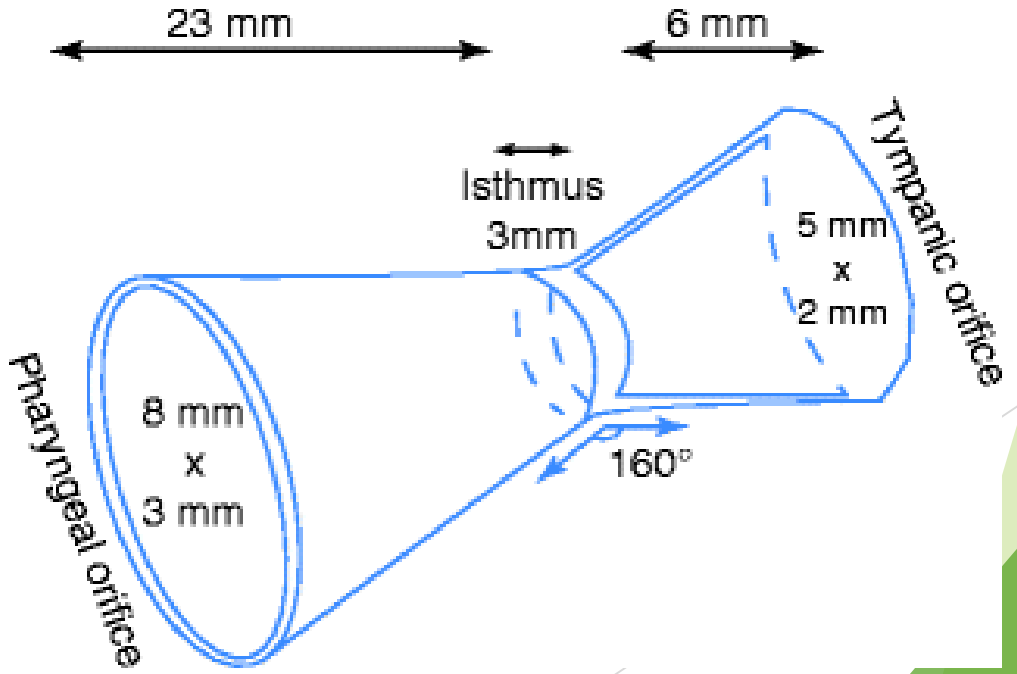
ANATOMY

- Eustachian tube also called AUDITORY or PHARYNGOTYMPANIC TUBE, connects nasopharynx with the tympanic cavity.
- It is about 36mm long and runs downward, forward and medially from its tympanic end, forming an angle of 45° with the horizontal.
- Divided into two parts: BONY, which is posterolateral forms one-third (12mm) and FIBROCARTILAGINOUS, which is anteromedial, form two-third (24mm). The two parts meet at isthmus which is narrowest part of tube.
- The fibrocartilaginous part of the tube is made up of a single piece of cartilage folded upon itself in such a way that it form whole of medial lamina, roof and a part of lateral lamina; the rest of its lateral lamina is made of fibrous membrane.



Right Eustachian tube



- The tympanic end of the tube is bony, measures 5 × 2mm and is situated in the anterior wall of middle ear, a little above the end of floor.

- The pharyngeal end of the tube is slit-like vertically and the cartilage at this end raises an elevation called TORUS TUBARIUS, which is situated in the lateral wall of the nasopharynx, 1-1.25cm behind the posterior end of inferior turbinate.

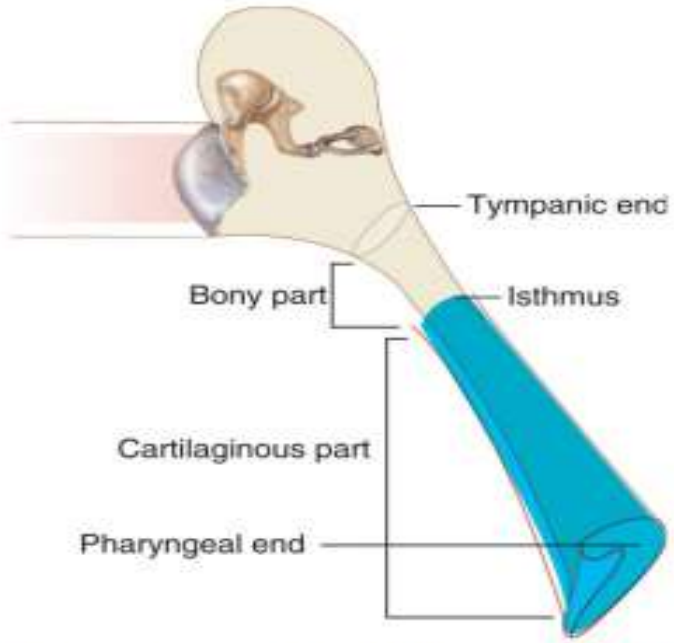
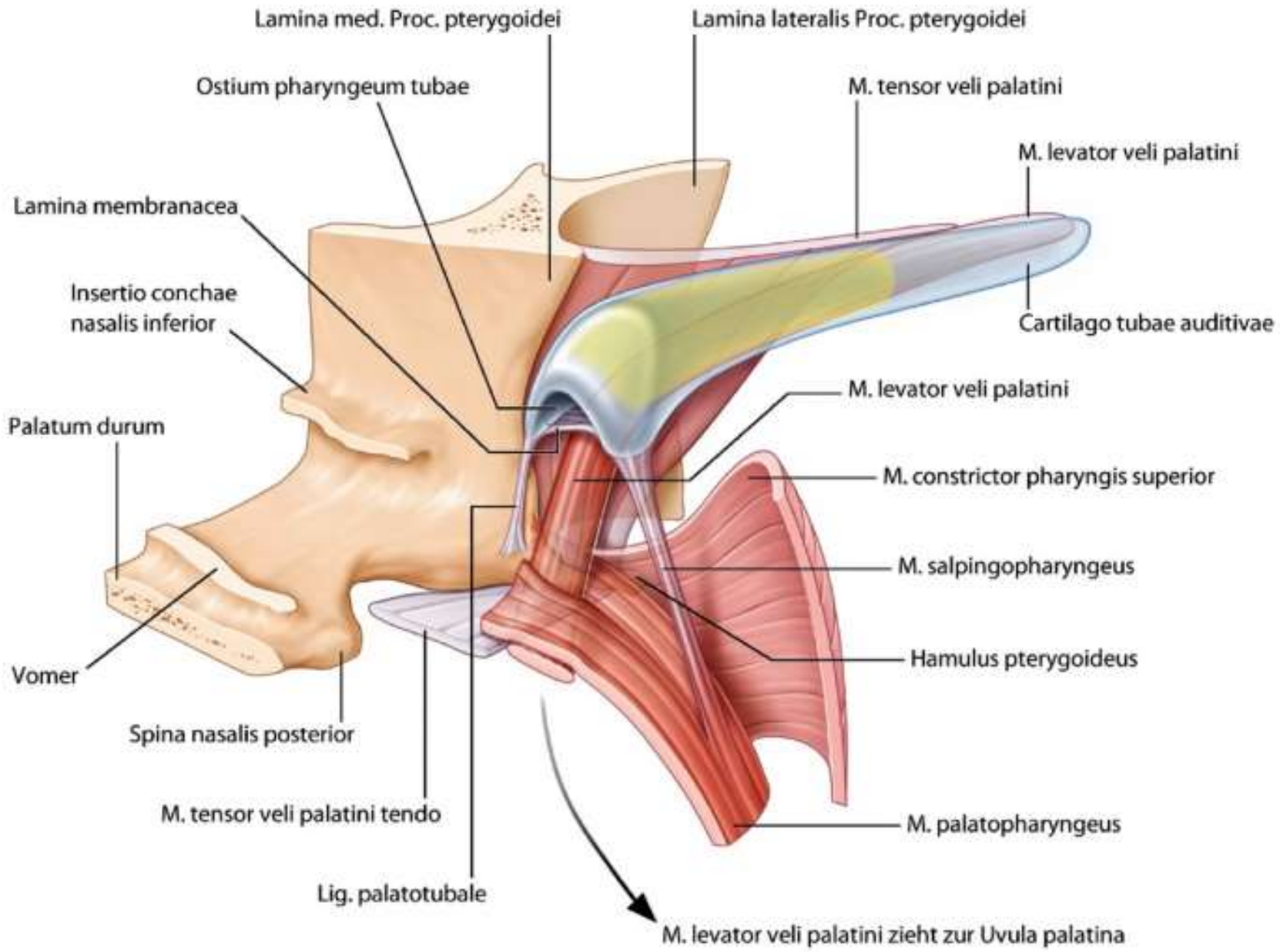


Figure 9.1. Horizontal section through the eustachian tube showing bony and cartilaginous parts, isthmus, tympanic and pharyngeal ends.

STRUCTURES

Muscles Related To Eustachian Tube

- Three muscles are related to the tube: tensor veli palatini, levator veli palatini and salpingopharyngeus.
- The medial fibres of the tensor veli palatini are attached to the lateral lamina of the tube and when they contract help to open the tubal lumen. These fibres have also been called *dilator tubae* muscle.
- The exact role of the levator veli palatini and the salpingopharyngeus muscles to open the tube is uncertain. It is believed that the levator veli palatini muscle, which runs inferior and parallel to the cartilaginous part of the tube forms a bulk under the medial lamina and during contraction pushes it upward and medially thus assisting in opening the tube.


Lamina med. Proc. pterygoidei
Lamina lateralis Proc. pterygoidei
Ostium pharyngeum tubae
M. tensor veli palatini
M. levator veli palatini
Lamina membranacea
Insertio conchae nasalis inferior
Cartilago tubae auditivae
M. levator veli palatini
Palatum durum
M. constrictor pharyngis superior
M. salpingopharyngeus
Hamulus pterygoideus
Vomer
Spina nasalis posterior
M. tensor veli palatini tendo
M. palatopharyngeus
Lig. palatotubale
M. levator veli palatini zieht zur Uvula palatina

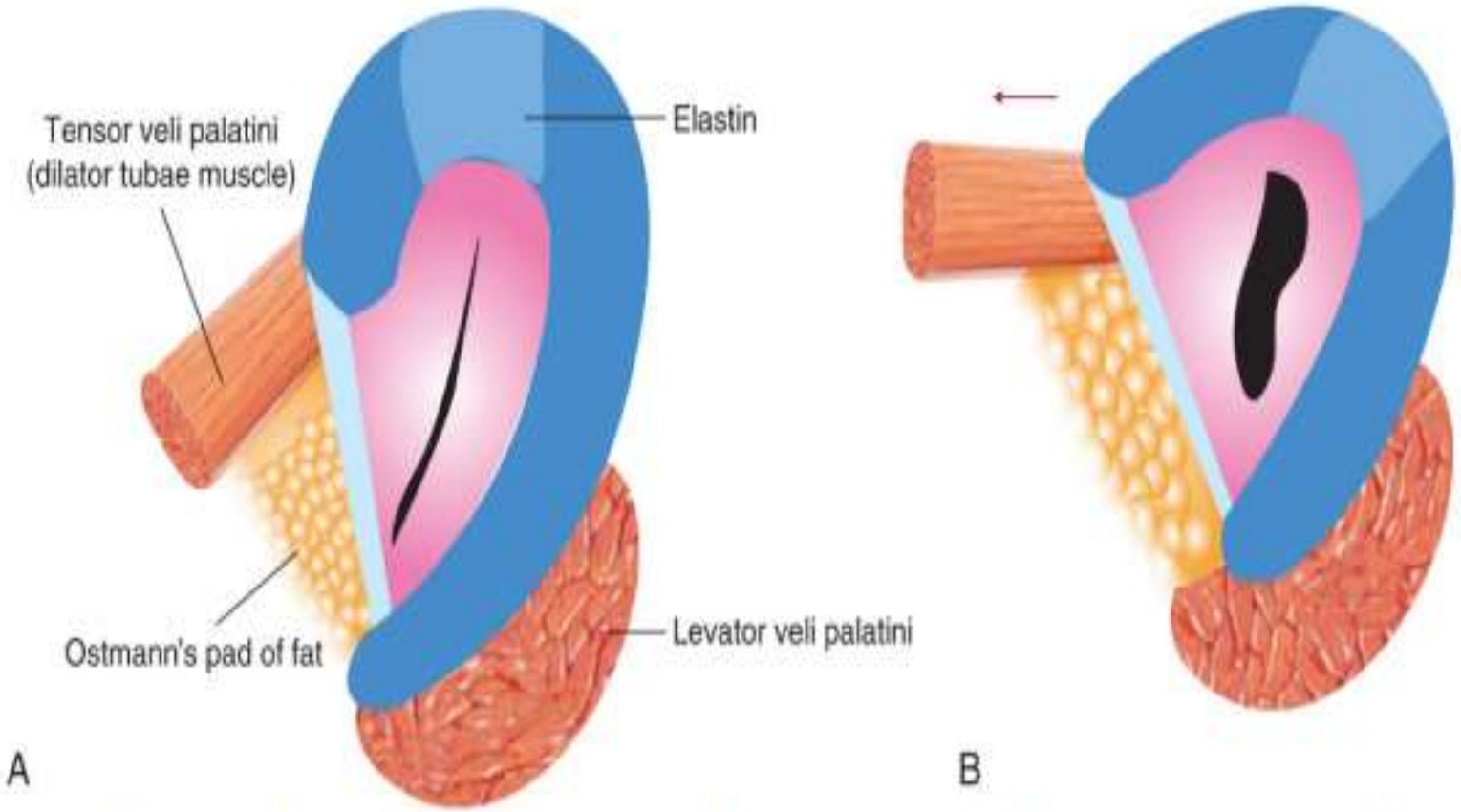
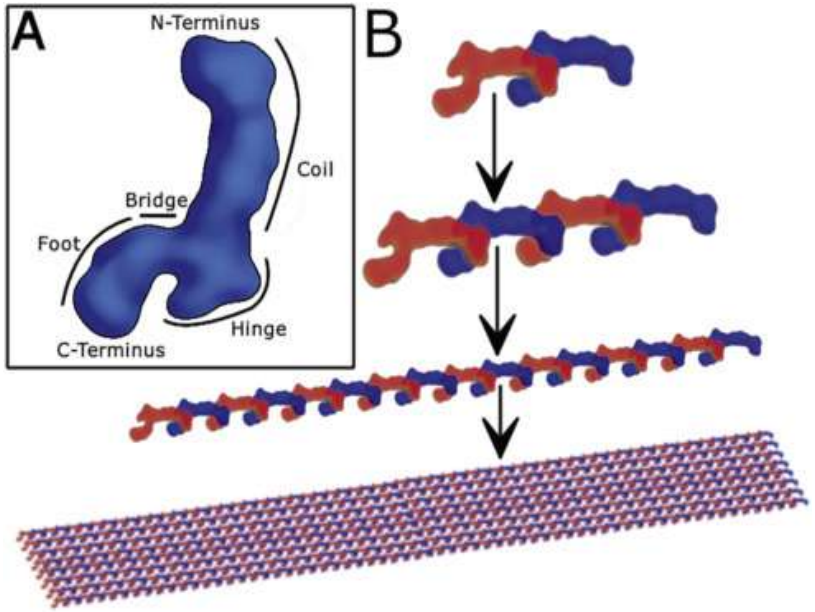
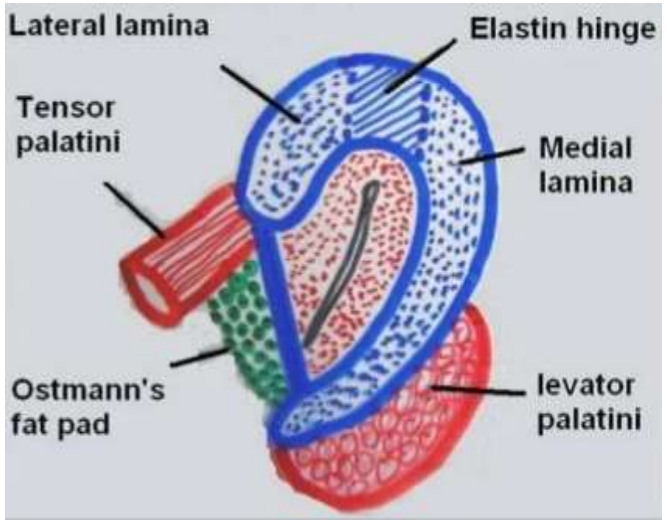


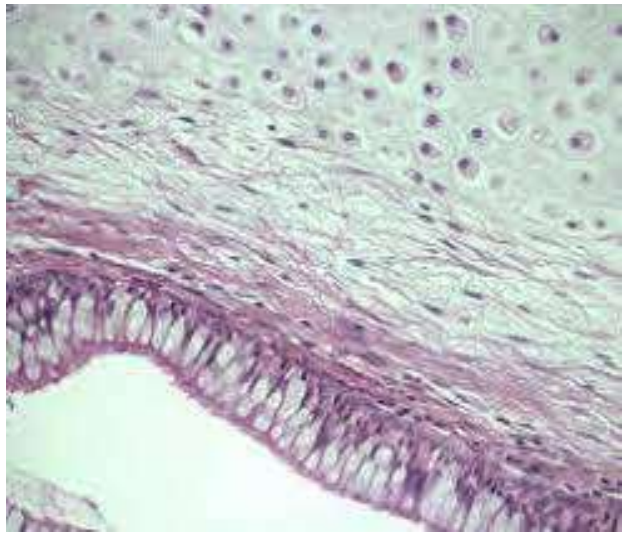
Figure 9.2. Vertical section through eustachian tube. Note: Cartilage of the tube forms medial wall, roof and part of lateral wall. Elastin is situated in the roof at the junction of medial and lateral laminae and helps the medial laminae to regain its original position of closure. (A) Eustachian tube is closed in resting position. (B) Tube is open when tensor veli palatini (dilator tubae) muscle contracts.

The elastin hinge. The cartilage, at the junction of medial, and lateral lamina at the roof, is rich in elastin fibres which form a hinge. By its recoil it helps to keep the tube close when no longer acted upon by dilator tubae muscle.

Ostmann's pad of fat. It is a mass of fatty tissues related laterally to the membranous part of the cartilaginous tube. It also helps to keep the tube closed and thus protect it from the reflux of nasopharyngeal secretions.







LINING OF THE EUSTACHIAN TUBE

Histologically, the mucosa shows pseudostratified ciliated columnar epithelium interspersed with mucous secreting goblet cells. Submucosa, particularly in the cartilaginous part of the tube, is rich in seromucinous glands. The cilia beat in the direction of nasopharynx and thus help to drain secretions and fluid from the middle ear into the nasopharynx.

NERVE SUPPLY

Tympanic branch of cranial nerve (CN) IX supplies sensory as well as parasympathetic secretomotor fibres to the tubal mucosa. Tensor veli palatini muscle is supplied by mandibular branch of trigeminal (V3) nerve. Levator veli palatini and salpingopharyngeus muscles receive motor nerve supply through pharyngeal plexus (cranial part of CN XI through vagus).

TABLE 9.1 DIFFERENCES BETWEEN INFANT AND ADULT EUSTACHIAN TUBE

	Infant	Adult
Length	13–18 mm at birth (about half as long as in adult)	36 mm (31–38 mm)
Direction	More horizontal. At birth, it forms an angle of 10° with the horizontal. At age 7 and later it is 45°	Forms an angle of 45° with the horizontal
Angulation at isthmus	No angulation	Angulation present
Bony versus cartilaginous part	Bony part is slightly longer than one-third of the total length of the tube and is relatively wider	Bony part one-third; cartilaginous part two-thirds
Tubal cartilage	Flaccid. Retrograde reflux of nasopharyngeal secretions can occur	Comparatively rigid. Remains closed and protects the middle ear from the reflux
Density of elastin at the hinge	Less dense; tube does not efficiently close by recoil	Density of elastin more and helps to keep the tube closed by recoil of cartilage
Ostmann's pad of fat	Less in volume	Large and helps to keep the tube closed

FUNCTIONS

Physiologically, eustachian tube performs three main functions:

1. Ventilation and regulation of middle ear pressure.

2. Protection against

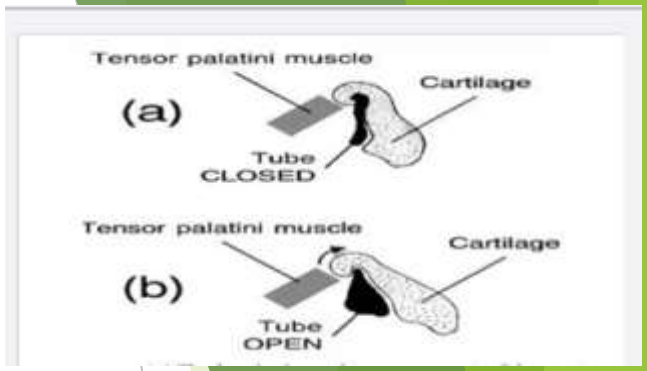
(i) nasopharyngeal sound pressure

(ii) reflux of nasopharyngeal secretions.

3. Clearance of middle ear secretions.

1. Ventilation and Regulation of Middle Ear

Pressure. For normal hearing, it is essential that pressure on two sides of the tympanic membrane should be equal.



- Negative or positive pressure in the middle ear affects hearing. Thus, eustachian tube should open periodically to equilibrate the air pressure in the middle ear with the ambient pressure.
- Normally, the eustachian tube remains closedand opens intermittently during swallowing, yawning and sneezing. Posture also affectsthe function; tubal opening is less efficient in recumbent position and during sleep due to venous engorgement.
- Tubal function is also poor in infants and young children andthusresponsible for more earproblems in that age group. It usually normalizes by the ageof 7–10 years.

2. Protective Functions. Abnormally, high sound pressures from the nasopharynx can be transmitted to the middle ear if the tube is open thus interfering with normal hearing.

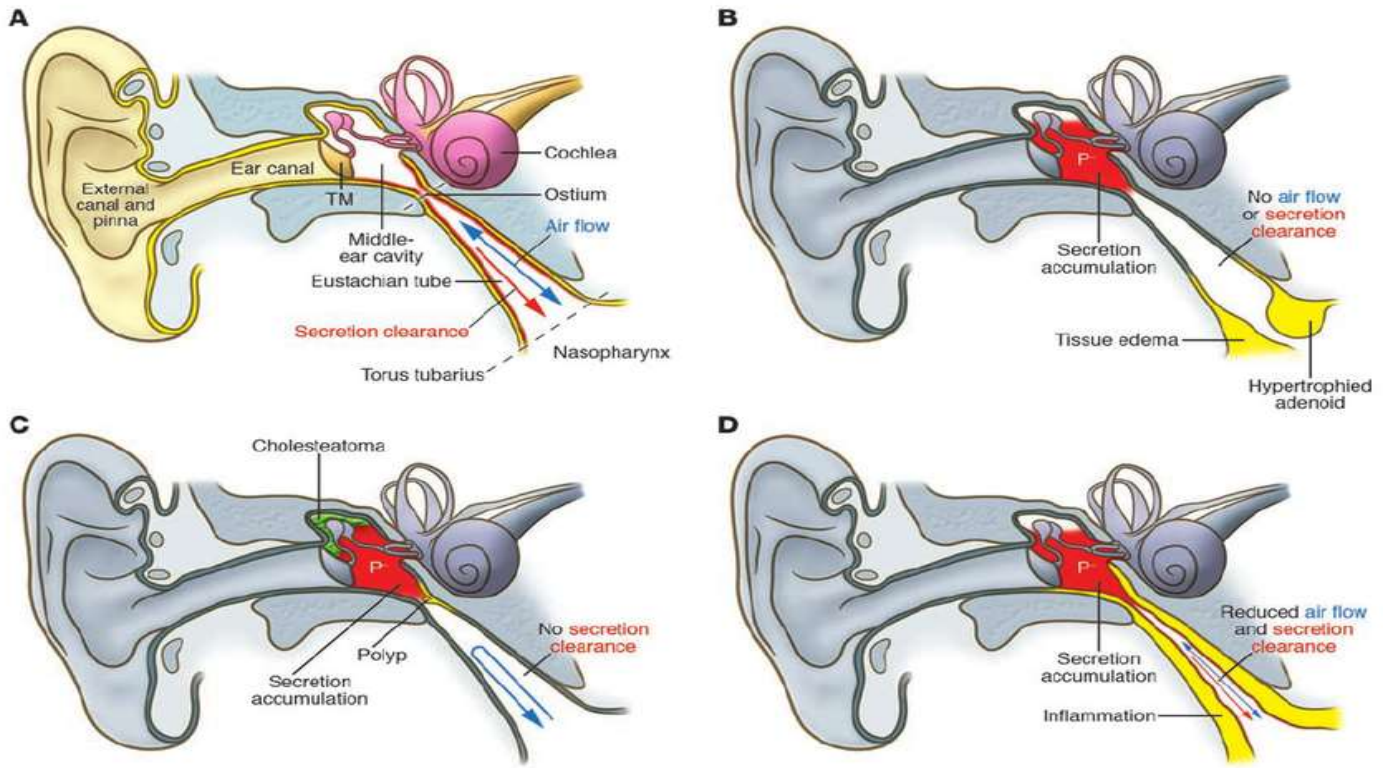
- Normally, the eustachian tube remains closed and protects the middle ear against these sounds.
- A normal eustachian tube also protects the middle ear from reflux of nasopharyngeal secretions into the middle ear.
- This reflux occurs more readily if the tube is wide in diameter (patulous tube), short in length (as in babies) or the tympanic membrane is perforated (cause for persistence of middle ear infections in cases of tympanic membrane perforations).
- High pressures in the nasopharynx can also force nasopharyngeal secretions into the middle ear, e.g. forceful nose blowing, closed-nose swallowing as in the presence of adenoids or bilateral nasal obstruction.

3. Clearance of Middle Ear Secretions. Mucous membrane of the eustachian tube and anterior part of the middle ear is lined by ciliated columnar cells.

The cilia beat in the direction of nasopharynx.

This helps to clear the secretions and debris in the middle ear towards the nasopharynx.

The clearance function is further augmented by active opening and closing of the tube.



EUSTACHIAN TUBE FUNCTION TESTS

- **1. Valsalva Test.** The principle of this test, as also of politzerization, is to build positive

  pressure in the nasopharynx so that air enters the eustachian tube.

- To do this test, patient pinches his nose between the thumb and index finger, takes a

  deep breath, closes his mouth and tries to blow air into the ears.

- If air enters the middle ear, the tympanic membrane will move outwards, which can

  be verified by otoscope or the microscope.

- In the presence of a tympanic membrane perforation, a hissing sound is produced.

- Failure of this test does not prove blockage of the tube because only about 65% of persons can successfully perform this test.
- This test should be avoided

  (i) in the presence of atrophic scar of tympanic membrane which can rupture

  (ii) in the presence of infection of nose and nasopharynx where infected secretions are likely to be pushed into the middle ear causing otitis media.

2. Politzer Test- This test is done in children who are unable to perform Valsalva test.

- In this test, olive-shaped tip of the Politzer's bag is introduced into the patient's nostril on the side of which the tubal function is desired to be tested.
- Other nostril is closed, and the bag compressed while at the same time the patient swallows (he can be given sips of water) or says "ik, ik, ik."
- By means of an auscultation tube, connecting the patient's ear under test to that of the examiner, a hissing sound is heard if tube is patent.

- Compressed air can also be used instead of Politzer's bag. The test is also used therapeutically to ventilate the middle ear.

a. Politzer bag

b. Politzerization

3. Catheterization- In this test, nose is first anaesthetized by topical spray of lignocaine.

- Then a eustachian tube catheter, the tip of which is bent, is passed along the floor of nose till it reaches the nasopharynx.
- Here it is rotated 90° medially and gradually pulled back till it engages on the posterior border of nasal septum.
- It is then rotated 180° laterally so that the tip lies against the tubal opening.
- A Politzer's bag is now connected to the catheter and air insufflated.
- Entry of air into the middle ear is verified by an auscultation tube.

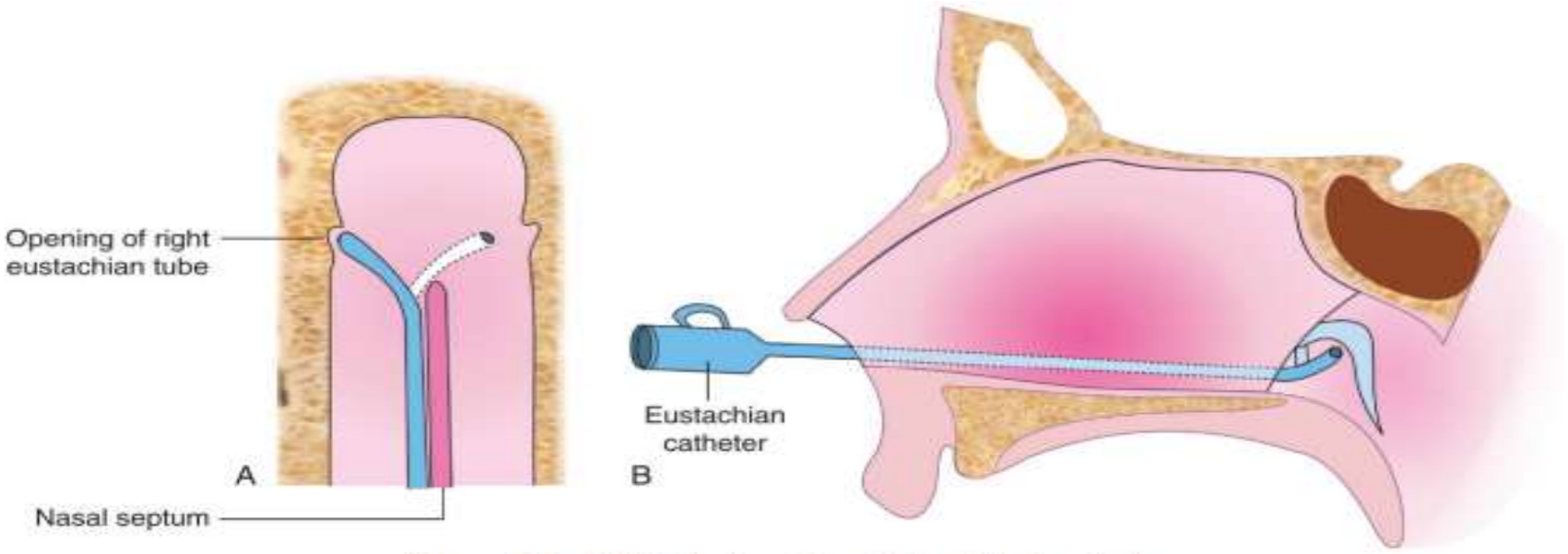


Figure 9.3. Catheterization of eustachian tube (see text).

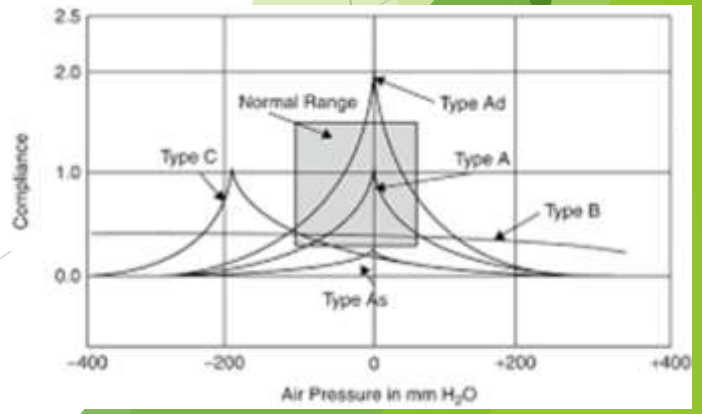
- The procedure of catheterization should be gentle as it is known to cause complications such as:
- (a) Injury to eustachian tube opening which causes scarring later.
- (b) Bleeding from the nose.
- (c) Transmission of nasal and nasopharyngeal infection into the middle ear causing otitis media.
- (d) Rupture of atrophic area of tympanic membrane if too much pressure is used.

4. Toynbee's Test- While the above three tests use a positive pressure, Toynbee's manoeuvre causes negative pressure.

- It is a more physiological test.
- It is performed by asking the patient to swallow while nose has been pinched.
- This draws air from the middle ear into the nasopharynx and causes inward movement of tympanic membrane, which is verified by the examiner otoscopically or with a microscope.

5. Tympanometry (Also Called Inflation–Deflation Test)

- In this test, positive and negative pressures are created in the external ear canal and the patient swallows repeatedly.
- The ability of the tube to equilibrate positive and negative pressures to the ambient pressure indicates normal tubal function.
- The test can be done both in patients with perforated or intact tympanic membranes



6. Radiological Test. A radio-opaque dye, e.g. hypaque or lipoidal instilled into the middle ear through a pre-existing perforation.

- X-rays taken should delineate the tube and any obstruction.
- The time taken by the dye to reach the nasopharynx also indicates its clearance function. This test is no longer popular now.

7. Saccharine or Methylene Blue Test. Saccharine solution is placed into the middle ear through a pre-existing perforation.

- The time taken by it to reach the pharynx and impart a sweet taste is also a measure of clearance function.
- Similarly, methylene blue dye can be instilled into the middle ear and the time taken by it to stain the pharyngeal secretions can be noted.
- Indirect evidence of drainage/clearance function is established when ear drops instilled into the ear with tympanic membrane perforation cause bad taste in throat.

8. Sonotubometry. A tone is presented to the nose and its recording taken from the external canal.

- The tone is heard louder when the tube is patent (compare patulous eustachian tube).
- It also tells the duration for which the tube remains open.
- It is a noninvasive technique and provides information on active tubal opening.
- Accessory sounds produced in the nasopharynx, during swallowing, may interfere with the test results.
- The test is under development.

DISORDERS OF EUSTACHIAN TUBE

1. Tubal Blockage. Normally, eustachian tube is closed.

- It opens intermittently during swallowing, yawning and sneezing through the active contraction of tensor veli palatini muscle.
- Air, composed of oxygen, carbon dioxide, nitrogen and water vapour, normally fills the middle ear and mastoid.
- When tube is blocked, first oxygen is absorbed, but later other gases, CO_2 and nitrogen also diffuse out into the blood.
- This results in negative pressure in the middle ear and retraction of tympanic membrane.

- If negative pressure is still further increased, it causes “locking” of the tube with collection of transudate and later exudate and even haemorrhage.

- Effects of acute and long-term tubal blockage are –

Acute tubal blockage -Absorption of ME gases -Negative pressure in ME -Retraction of TM -Transudate in ME/haemorrhage (acute otitis media with effusion)

- Prolonged tubal blockage/dysfunction -OME (thin watery or mucoid discharge) -Atelectatic ear/perforation -Retraction pocket/cholesteatoma -Erosion of incudostapedial joint.

- Eustachian tube obstruction can be mechanical, functional or both.
- *Mechanical obstruction* can result from

(i) intrinsic causes such as inflammation or allergy

(ii) extrinsic causes such as tumour in the nasopharynx or adenoids.

- *Functional obstruction* is caused by collapse of the tube due to increased cartilage compliance, which resists opening of the tube or failure of active tubal-opening mechanism due to poor function of tensor veli palatini.
- The common clinical conditions which can cause tubal obstruction are - Upper respiratory infection (viral or bacterial) • Allergy • Sinusitis • Nasal polyps • Deviated nasal septum • Hypertrophic adenoids • Nasopharyngeal tumour/mass • Cleft palate • Submucous cleft palate • Down syndrome • Functional

- Symptoms of tubal occlusion include otalgia, which may be mild to severe, hearing loss, popping sensation, tinnitus and disturbances of equilibrium or even vertigo.
- Signs of tubal occlusion will vary and depend upon the acuteness of the condition and severity.
- They include retracted tympanic membrane, congestion along the handle of malleus and the pars tensa, transudate behind the tympanic membrane, imparting it an amber colour and sometimes a fluid level with conductive hearing loss.
- In severe cases, as in barotrauma, tympanic membrane is markedly retracted with haemorrhages in subepithelial layer, haemotympanum or sometimes a perforation.

- **2. Adenoids and Eustachian Tube Function.** Adenoids cause tubal dysfunction by:

(a) Mechanical obstruction of the tubal opening.

(b) Acting as reservoir for pathogenic organisms.

(c) In cases of allergy, mast cells of the adenoid tissue release inflammatory mediators which cause tubal blockage.

- Thus, adenoids can cause otitis media with effusion or recurrent acute otitis media.

- Adenoidectomy can help both these conditions.

- **3. Cleft Palate and Tubal Function.** Tubal function is disturbed in cleft palate patients due to:

(a) Abnormalities of torus tubarius, which shows high elastin density making tube difficult to open.

(b) Tensor veli palatini muscle does not insert into the torus tubarius in 40% cases of cleft palate and where it does insert, its function is poor.

- Otitis media with effusion is common in these patients.

- Even after repair of the cleft palate deformity, many of them require insertion of grommets to ventilate the middle ear.

4. Down Syndrome and Tubal Function. Function of eustachian tube is defective possibly due to poor tone of tensor veli palatini muscle and abnormal shape of nasopharynx.

- Children with this syndrome are prone to frequent otitis media or otitis media with effusion.

5. Barotrauma

RETRACTION POCKETS AND EUSTACHIAN TUBE

- In ventilation of the middle ear cleft, air passes from eustachian tube to mesotympanum, from there to attic, aditus, antrum and mastoid air cell system.
- Mesotympanum communicates with the attic via anterior and posterior isthmi, situated in membranous diaphragm between the mesotympanum and the attic.
- *Anterior isthmus* is situated between tendon of tensor tympani and the stapes.
- *Posterior isthmus* is situated between tendon of stapedius muscle and pyramid, and the short process of incus.
- In some cases, middle ear can also communicate directly with the mastoid air cells through the retrofacial cells.

- Any obstruction in the pathways of ventilation can cause retraction pockets or atelectasis of tympanic membrane, e.g.

1. Obstruction of eustachian tube → Total atelectasis of tympanic membrane.

2. Obstruction in middle ear → Retraction pocket in posterior part of middle ear while anterior part is ventilated.

3. Obstruction of isthmi → Attic retraction pocket.

4. Obstruction at aditus → Cholesterol granuloma and collection of mucoid discharge in mastoid air cells, while middle ear and attic appear normal.

- Depending on the location of pathologic process, other changes such as thin atrophic tympanic membrane, partial or total (due to absorption of middle fibrous layer), cholesteatoma, ossicular necrosis and tympanosclerotic changes may also be found.

PATULOUS EUSTACHIAN TUBE In this condition, the eustachian tube is abnormally patent.

- Most of the time it is idiopathic but rapid weight loss, pregnancy especially third trimester, or multiple sclerosis can also cause it.
- Patient's chief complaints are hearing his own voice (autophony), even his own breath sounds, which is very disturbing.
- Due to abnormal potency, pressure changes in the nasopharynx are easily transmitted to the middle ear so much so that the movements of tympanic can be seen with inspiration and expiration; these movements are further exaggerated if patient breathes after closing the opposite nostril.
- Acute condition of patulous tube is self-limiting and does not require treatment.
- In others, weight gain, oral administration of potassium iodide is helpful but some long-standing cases may require cauterization of the tubes or insertion of a grommet.

- **EXAMINATION OF EUSTACHIAN TUBE** *Pharyngeal end* of the eustachian tube can be examined by posterior rhinoscopy, rigid nasal endoscope or flexible nasopharyngoscope.
- *Tympanic end* of the tube can be examined by microscope or endoscope, if there is a pre-existing perforation.
- Eustachian tube endoscopy or middle ear endoscopy can be done with very fine flexible endoscopes.
- Simple examination of tympanic membrane with otoscope or microscope may reveal retraction pockets or fluid in the middle ear.
- Similarly, movements of tympanic membrane with respiration point to patulous eustachian tube.
- Further assessment of function of the tube can be made by Valsalva, politzerization, Toynbee and other tests.

- *Aetiologic causes* of eustachian tube dysfunction can be assessed by thorough nasal examination including endoscopy, tests of allergy, CT scan of temporal bones and of paranasal sinuses.

- MRI may be required to exclude multiple sclerosis in patulous eustachian tube.