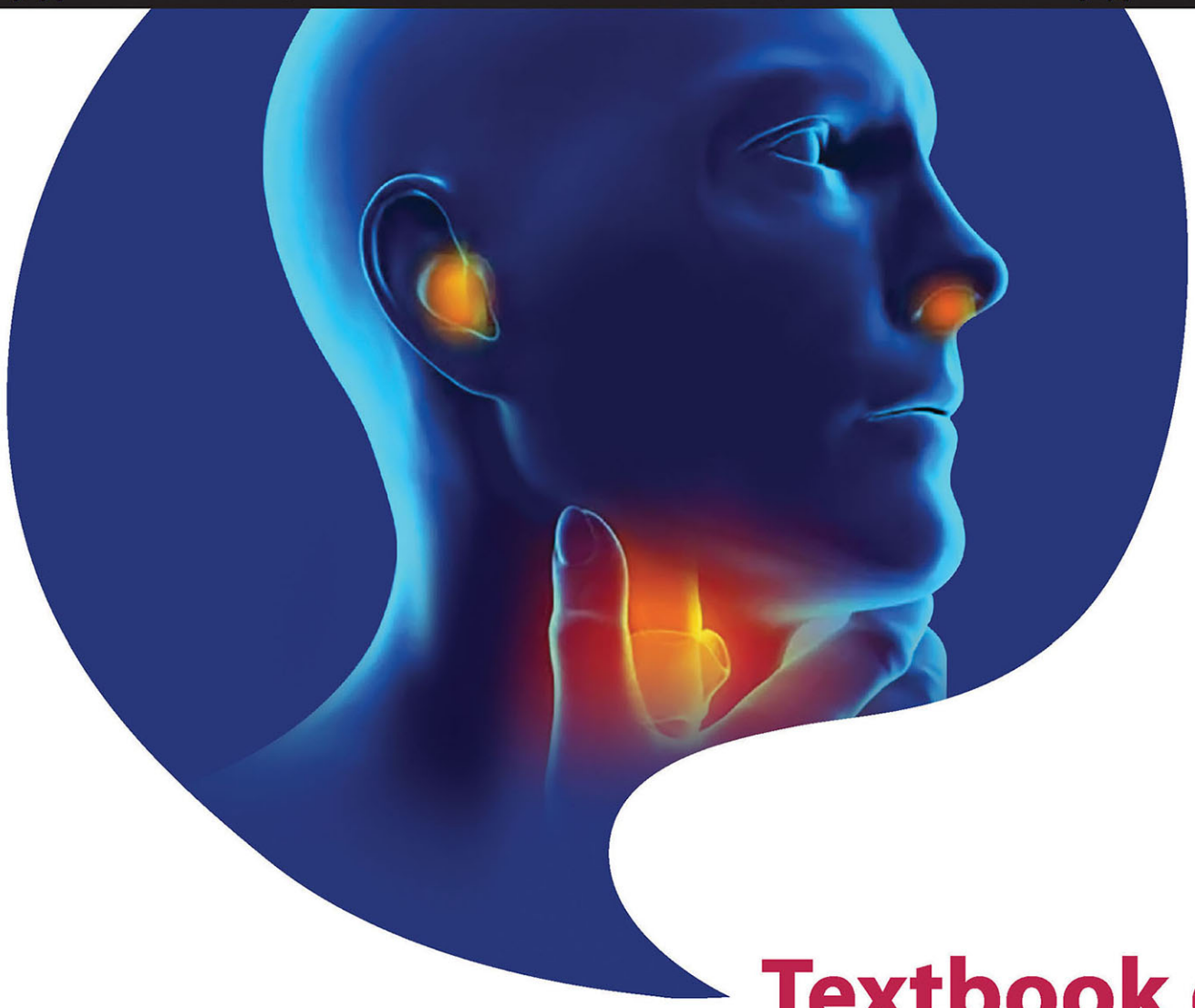
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Textbook of Ear, Nose & Throat

with Head and Neck Surgery

for Medical Students

Including Clinical & Pathological Aspects

As per the Competency Based Medical Education Curriculum (NMC)

Hitesh Verma

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Contents

Section 1: Ear

Chapter 1: Anatomy of Ear and Physiology of Hearing 3
- Development of Ear *3*
- Anatomy and Physiology of External Ear *3*
- Middle Ear Anatomy *4*
- Anatomy of the Inner Ear *5*
- Physiology *8*

Chapter 2: Hearing Evaluation 12
- Pure Tone Audiometry *12*
- Speech Audiometry *14*
- Special Test of Hearing *14*
- Objective Tests *15*
- Disability Assessment *18*
- Functional Hearing Loss *19*

Chapter 3: Diseases of External Ear 21
- External Ear Developmental Anomalies *21*
- Diseases of Pinna *21*
- Diseases of the External Auditory Canal *22*
- Malignant Lesion of External Ear *25*

Chapter 4: Eustachian Tube Function Test and Otitis Media 30
- Anatomy of Eustachian Tube *30*
- Eustachian Tube Dysfunction *30*
- Acute Otitis Media *32*

Chapter 5: Tympanic Membrane Anatomy, Diseases, and Myringoplasty 37
- Anatomy of the Tympanic Membrane *37*
- Pars Tensa Perforation *38*
- Traumatic Perforation *41*
- Granular Myringitis *41*
- Myringitis Bullosa *41*
- Tuberculosis *41*

Chapter 6: Complications of Middle Ear Infection 44
- Types of Complications *44*
- Intratemporal Complications *44*
- Extratemporal or Extracranial Complications *46*
- Intracranial Complications *46*

Chapter 7: Chronic Otitis Media, Cholesteatoma, and Tympanoplasty 50
- Chronic Otitis Media *50*
- Cholesteatoma *51*

Chapter 8: Mastoid Surgeries 58
- Soft Tissue Approaches *58*
- Bony Approaches *58*
- Postoperative Care *61*
- The Drawbacks of Canal Wall Up and Canal Wall Down Procedures and Management *62*

Chapter 9: Otosclerosis 65
- Etiology and Types *65*
- Clinical Features *65*
- Differential Diagnosis for CHL *65*
- Diagnosis *66*
- Treatment *66*

Chapter 10: Facial Nerve 72
- Anatomy *72*
- Surgical Landmarks for Facial Nerve *74*
- Functions of Facial Nerve *74*
- Etiology of Facial Nerve Palsy *75*
- Grading System *75*
- Investigations *75*
- Differential Diagnosis of Facial Palsy *78*
- Dynamic Procedures *79*
- Tumor *79*

Chapter 11: Sensorineural Hearing Loss: Causes, Evaluation, and Management 83
- Causes *83*
- Evaluation of Hearing Loss *83*
- Hearing Rehabilitation *84*
- Surgical Methods *86*
- Advance Devices *88*
- Other Causes of Sensorineural Hearing Loss *89*
- Noise-induced Hearing Loss *89*
- Sudden Sensorineural Hearing Loss *90*
- Presbycusis *90*

Chapter 12: Anatomy and Tumor of Temporal Bone 93
- Anatomy *93*
- Tumors *94*
- Paraganglioma (Glomus Tumor) *94*
- Vestibular Schwannoma *95*
- Endolymphatic Sac Tumor *96*
- Temporal Bone Malignant Lesions *96*

Chapter 13: Tinnitus 99
- Types and Etiology *99*
- Pathophysiology *99*
- Workup *99*
- Examination and Investigations *100*
- Treatment *101*

Chapter 14: Differential Diagnosis for Ear Symptoms 103
- Hearing Loss *103*
- Otalgia *105*
- Ear Discharge *105*
- Ear Fullness *106*
- Examination *106*
- Investigations *107*
- Management *107*

JAYPEE BROTHERS

Chapter 15: Anatomy and Physiology of Vestibule and Vertigo 109
- Anatomy of Vestibular System *109*
- Vertigo *110*

Chapter 16: Examination of Ear 119
- History and Examination *119*
- Outpatient Department Setup *119*
- Examination of External Ear *120*
- Examination of Tympanic Membrane *121*
- Investigations *126*
- Treatment Plan *127*

Chapter 17: Ear Instruments 129
- Outpatient Department Instruments *129*
- OT Instruments *132*

Section 2: Nose

Chapter 18: Anatomy of Nose 139
- External Nose *139*
- Nasal Vestibule *141*
- Nasal Septum *142*
- Developmental Anatomy *143*

Chapter 19: Anatomy of Nasal Cavity Proper 146
- Lateral Nasal Wall *146*
- Paranasal Sinuses *149*
- Skull Base *150*

Chapter 20: Physiology of Nose 153
- Nasal Functions *153*
- Olfaction *154*

Chapter 21: Acute and Chronic Rhinosinusitis 159
- Acute Rhinosinusitis *159*
- Chronic Rhinosinusitis *163*

Chapter 22: Allergic Rhinitis, Vasomotor Rhinitis and Fungal Rhinosinusitis 167
- Allergic Rhinitis *167*
- Vasomotor Rhinitis *170*
- Fungal Sinusitis *170*
- Atrophic Rhinitis *172*

Chapter 23: Complications of Sinusitis 176
- Workup *176*
- Orbital Complications *176*
- Intracranial Complications *178*
- Local Complications *178*

Chapter 24: Anatomy of Nasal Septum, Septal Surgeries, and Complications 181
- Deviated Nasal Septum *181*
- Demography *187*

Chapter 25: Epistaxis 187
- Anatomy *187*
- Classification *188*
- Etiology *188*
- Clinical Assessment *188*
- Investigations *188*
- Management *189*
- Hereditary Hemorrhagic Telangiectasia *191*

Chapter 26: Facial Trauma 194
- Fracture Types and Management *194*
- Cerebrospinal Fluid Rhinorrhea *199*

Chapter 27: Cerebrospinal Fluid Rhinorrhea, Choanal Atresia, Mucocele, and Dacryocystitis 199
- Choanal Atresia *201*
- Mucocele *201*
- Dacryocystitis *203*

Chapter 28: Orbit and Optic Nerve 206
- Proptosis *206*
- Optic Neuropathy *208*

Chapter 29: Granulomatous Diseases of Nose 211
- Types *211*
- Tuberculosis *211*
- Leprosy *211*
- Syphilis *211*
- Rhinoscleroma *212*
- Actinomycosis *212*
- Rhinosporidiosis *212*
- *Entomophthoromycosis conidiobolus* (Rhinophycomycosis) *213*
- Nasal Leishmaniasis *213*
- Granulomatosis with Polyangiitis (Wegener Granulomatosis) *213*
- Sarcoidosis *213*
- Natural Killer T Cell Lymphoma *213*
- Myiasis *214*

Chapter 30: Benign Lesions of Nose and Paranasal Sinuses 216
- Benign Lesions *216*
- Maxillary Sinus Carcinoma *223*

Chapter 31: Malignant Lesion of Nose and Paranasal Sinus 223
- Esthesioneuroblastoma *226*

Chapter 32: Common Surgical Approaches for Sinonasal Lesions 229
- Functional Endoscopic Sinus Surgery *229*
- Maxillectomy *232*
- External Frontoethmoidectomy *232*
- Caldwell-Luc Operation *233*

Chapter 33: Obstructive Sleep Apnea 236
- Snoring and Sleep Apnea *236*

Chapter 34: Examination of Nose and Instruments 241
- External Nose Examination *241*
- Nasal Patency *242*
- Vestibule *242*
- Anterior Rhinoscopy *242*
- Posterior Rhinoscopy *243*
- Nasal Endoscopy *244*
- Nasal Obstruction *245*

Section 3: Upper Digestive Tract

Chapter 35: Anatomy of Oral Cavity and Pharynx 253
- Oral Cavity *253*
- Pharynx *256*
- Nasopharynx *256*
- Development of Oral Cavity and Pharynx *257*

Chapter 36: Swallowing and Dysphagia 260
- Swallowing *260*
- Dysphagia *261*
- Specific Dysphagia *263*

Chapter 37: Diseases of Adenoid and Tonsils 265
- Anatomy *265*
- Adenoiditis *266*

JAYPEE BROTHERS

- Tonsillitis *267*
- Benign Lesions of Oral Cavity *275*

Chapter 38: Benign Lesions, Inflammatory Lesions and Premalignant Lesions of the Oral Cavity 275
- Inflammatory Diseases *276*
- Premalignant Lesions of Oral Cavity *278*

Chapter 39: Malignant Lesions of Oral Cavity 282
- Etiologies/Risk Factors *282*
- Clinical Presentation *283*
- Workup *283*
- Radiology *284*
- Panendoscopy *284*
- Preoperative Management *284*
- Management *285*
- Lip Cancer *286*
- Carcinoma Anterior 2/3 of the Tongue *286*
- Carcinoma of Alveolar Ridge/Gingiva *287*
- Carcinoma of Buccal Mucosa *287*
- Carcinoma of Floor of Mouth *287*
- Carcinoma of Hard Palate *288*
- Carcinoma of RMT *288*
- Etiologies/Risk Factors *291*

Chapter 40: Malignant Lesions of Oropharynx 291
- Oropharyngeal Malignancy *291*
- Management *292*
- Carcinoma of Base of Tongue *293*
- Carcinoma of Tonsil *293*
- Carcinoma of Posterior Pharyngeal Wall *293*
- Soft Palate Tumor *293*

Chapter 41: Nasopharyngeal Pathologies 296
- Chordoma *296*
- Craniopharyngioma *296*
- Choristoma *296*
- Nasopharyngeal Carcinoma *297*

Chapter 42: Esophageal Pathologies 301
- Anatomy *301*
- Common Clinical Features *301*
- Investigations *301*
- Esophageal Diseases *304*

Chapter 43: Salivary Glands Anatomy and Diseases 309
- Embryology *309*
- Anatomy *309*
- Physiology *311*
- Salivary Gland Diseases *311*
- Benign Lesion *313*
- Malignant Lesion *315*

Section 4: Larynx

Chapter 44: Anatomy and Physiology of Larynx 321
- Anatomy of Larynx *321*
- Anatomy of Trachea *326*
- Physiology of Larynx *327*
- Voice Production *330*
- Impairment of Voice *330*

Chapter 45: Speech and Neurogenic Disorder of Larynx 330
- Neurogenic Illness of Larynx *331*
- Vocal Cord Palsy *332*
- Unilateral RLN Palsy *332*
- Bilateral RLN Palsy *333*
- Unilateral Superior Laryngeal Nerve Palsy *334*
- Unilateral Complete Vagal Palsy *334*
- Bilateral Complete Vagal Palsy *334*
- Muscle Tension Dysphonia *335*
- Other Causes for Abnormal Voice *335*

Chapter 46: Acute and Chronic Laryngitis 338
- Acute Laryngitis *338*
- Chronic Laryngitis *340*

Chapter 47: Benign Laryngeal Lesions 344
- Benign Mucosal Lesions *344*
- Other Benign Lesions *347*

Chapter 48: Laryngotracheal Trauma and Stenosis 351
- Acute Injury *351*
- Stenosis *352*

Chapter 49: Airway Obstruction, Stridor and Examination of Airway 358
- Stridor and Stertor *358*
- Examination of Airway *359*
- Management of Airway Diseases *365*

Chapter 50: Tracheostomy 368
- Types *368*
- Prerequisites for Tracheostomy *370*
- Surgical Steps of the Tracheostomy *370*
- Postoperative Care *373*
- Complications of Tracheostomy *374*

Chapter 51: Laryngeal and Hypopharyngeal Cancer 378
- Risk Factors *378*
- Premalignant Lesion *379*
- Clinical Presentation *379*
- Examination and Biopsy *379*
- Radiology *380*
- Staging *380*
- Treatment *383*
- Postlaryngectomy Voice Rehabilitation *387*

Chapter 52: Instruments for Oral Cavity, Pharynx and Esophagus 390
- Boyle Davis Mouth Gag *390*
- Dingman Mouth Gag *390*
- Draffin Bipod Stand and Maguran Plate *391*
- Denis Brown Tonsil Holding Forceps *391*
- Mollison's Tonsil Pillar Retractor and Dissector *391*
- Negus Artery Forceps *392*
- St Clair Thompson Adenoid Curette *392*
- Negus Knot Slipper *392*
- Waugh Forceps *392*
- Eva's Tonsillar Snare *392*
- Yankauer Suction Tip *392*
- Laryngology *392*

Section 5: Neck and Thyroid Gland

Chapter 53: Anatomy of Neck, Neck Spaces and Infections 397
- Anatomy of Neck *397*
- Spaces of Neck *398*

Chapter 54: Examination of Neck and Neck Masses 406
- Examination of Neck *406*
- Neck Masses *406*

Chapter 55: Neck Triangles, Level of Lymph Nodes and Neck Dissection 415
- Triangles of the Neck *415*
- Cervical Lymph Node Groups *416*
- Neck Dissection *418*

JAYPEE BROTHERS

Chapter 56: Thyroid Gland, Nodule and Goiter 422
- Physical Examination *423*
- Blood Investigation *424*
- USG *424*
- Common Thyroid Diseases *424*
- Workup *425*
- Staging System *426*
- Management *427*
- Postoperative Care *427*
- Prognostic Factors *427*

Section 6: Miscellaneous

Chapter 57: Foreign Bodies in ENT 433
- Ear Foreign Body *433*
- Nasal Foreign Body *434*
- Aerodigestive Foreign Bodies *434*
- Foreign Body Neck *437*

Chapter 58: ENT Radiology 439
- Ear *439*
- Nose and Paranasal Sinuses *442*
- Head and Neck *444*
- X-ray Cervical Spine *445*

Chapter 59: Kerosene Ingestion 449

Chapter 60: Simulator 452
- Target for Simulation Training *453*

Chapter 61: Grafts and Flaps in Otorhinolaryngology 456
- Grafts *456*
- Flaps *457*
- Postoperative Care *460*
- Drill Machine *462*

Chapter 62: Recent Advances 462
- Laser *462*
- Otoendoscope *463*
- Eustachian Tube Balloon Catheterization *463*
- Nerve Monitoring *463*
- Nasal Endoscopes *464*
- Microdebrider *464*
- Coblator *464*
- Navigation System *465*
- Radiofrequency Ablation *465*
- Bone Aspirator *465*
- Robotic System *465*
- TOUSS *466*
- Sialendoscope *466*

Chapter 63: ENT Manifestations of HIV Infection 469
- System Involvement *470*

Chapter 64: Topical Medications in ENT Practice 474
- Ear *474*
- Nose *475*
- Oral Cavity *476*

Chapter 65: Consent and Counseling 478
- Counseling *480*
- Tobacco Control Rules and Regulations *481*
- National Tobacco Control Programme *482*

Chapter 66: National Programs 484
- National Programme of Hearing *484*
- National Programme for Noise Pollution *487*
- World Health Organization Guidelines *488*
- National Programme for Prevention and Control of Cancer *488*

Index *491*

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5 CHAPTER

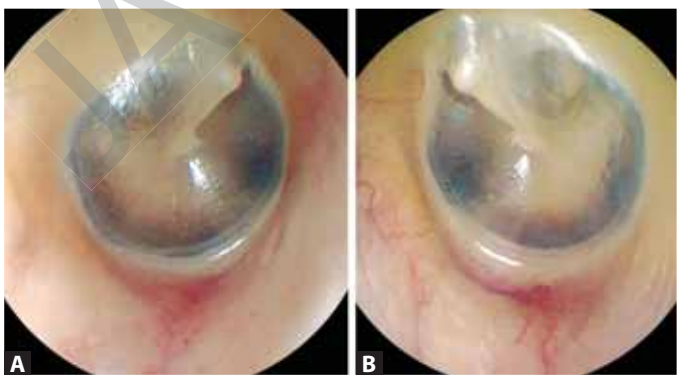
Tympanic Membrane Anatomy, Diseases, and Myringoplasty

EN 1.1: Describe the anatomy and physiology of ear, nose, throat, head and neck.

ANATOMY OF THE TYMPANIC MEMBRANE

The tympanic membrane separates the external ear from the middle ear. It faces in the laterally, downward, and forward direction. It is oval and pearly white. The tympanic membrane is placed obliquely at an angle of 55° with the floor of the external auditory canal and is much more horizontal in children. The thick peripheral margin of the tympanic membrane is known as the annulus, which sits in the tympanic sulcus **(Figs. 5.1 and 5.2)**.

Anterior and posterior malleolar folds are present between the upper end of the tympanic sulcus and the lateral process of the malleus, which divides the tympanic membrane into two parts. Pars tensa is the more significant, tense inferior part of the tympanic membrane, and pars flaccida (Shrapnell's membrane) is a small, triangular, loose upper part. These lines divide the pars tensa part of the tympanic membrane into four quadrants **(Figs. 5.3A and B)**. The dimensions are 10–11 × 8–9 × 0.1 mm. The longest dimension runs along with the malleus handle, and the shorter measurement is perpendicular to the longest dimension at the level of the umbo. It is a trilayer structure with concavity on the outer side. The outer layer is formed by stratified squamous keratinizing epithelium; the middle layer is by fibrous tissue (pars propria), and the inner layer is by ciliated columnar epithelium. The pars propria is formed by outer radial orientation and inner circularly oriented fibers. The middle layer splits at the umbo level to cover the malleus handle's distal part.



Figs. 5.1A and B: Right and left tympanic membrane (oval tympanic membrane, cone of light anteroinferiorly).

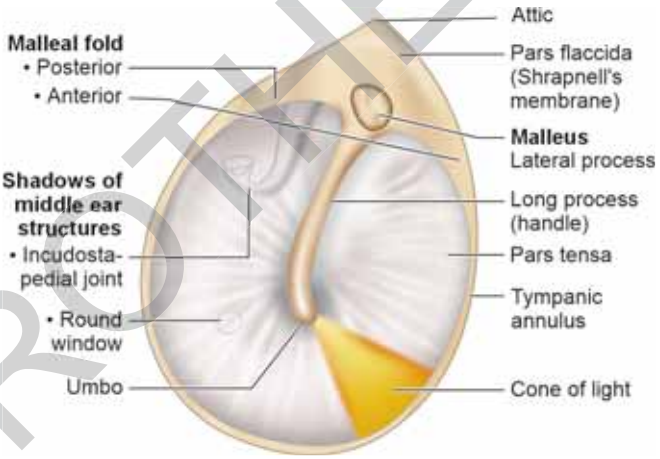
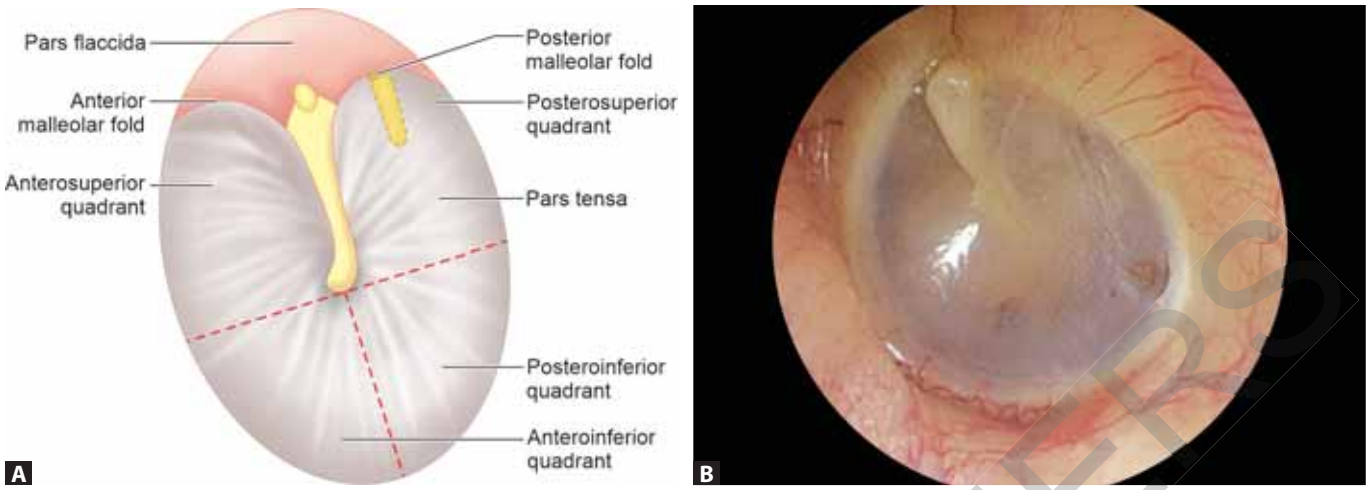


Fig. 5.2: Tympanic membrane showing attic, malleus handle, umbo, cone of light and structures of middle ear seen through it on otoscopy.

The arterial supply of the tympanic membrane runs within the middle layer. The deep auricular artery supplies the outer surface, whereas anterior tympanic and stylomastoid arteries supply the inner surface of the tympanic membrane. Branches of an auriculotemporal nerve (trigeminal nerve), vagus nerve, glossopharyngeal, and facial nerve supply the tympanic membrane.

- The poorly oriented fibers of the middle layer make the posterosuperior quadrant of the tympanic membrane and pars flaccida vulnerable to early retraction. The other causes of retraction in the posterosuperior part of tympanic membranes are lack of bony support, rich vascularity, the persistence of mucosal fold and bony separation between the epitympanic sinus and posterosuperior part, and farther distance from the Eustachian tube. The mucosal traction theory proposed mucosal pull between the incus and tympanic membrane to generate posterosuperior retraction.
- The etiology and risk factors for perforation and retraction of the tympanic membrane are accidental or iatrogenic trauma, Eustachian tube dysfunction, developmental abnormalities, smoking, poor hygiene, etc.

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Figs. 5.3A and B: (A) Division of right tympanic membrane; (B) Corresponding clinical photograph of right tympanic membrane.

EN 1.2: Describe the pathophysiology of common diseases in ENT.
EN 2.1: Elicit document and present an appropriate history in a patient presenting with an ENT complaint.
EN 4.6: Elicit document and present a correct history, demonstrate and describe clinical features, choose the correct investigations and describe the principles of management of discharging ear.

PARS TENSA PERFORATION

The perforation of pars tensa is divided based on site, size, and shape. It includes active and inactive chronic otitis media (COM) mucosal types. The perforation margin is healed, sharp, regular, and epithelized in the mucosal COM. Central perforation and tubotympanic disease are the terminologies used for pars tensa perforations. Bean or kidney-shaped perforation is the most common type.

- *Small perforation*: When it is confined to one quadrant of the tympanic membrane **(Fig. 5.4A)**.
- *Medium size perforation*: When perforation involves two quadrants **(Fig. 5.4B)**.
- *Large perforation*: When perforation involves all quadrants **(Fig. 5.4C)**.
- *Subtotal perforation*: Pars tensa is absent in all quadrants, but annulus is present **(Fig. 5.4D)**.
- *Total perforation*: Pars tensa and annulus is absent in all the quadrants **(Fig. 5.4E)**.
- *Marginal perforation*: The part of the annulus is absent with the pars tensa perforation. The risk of epithelial migration into the middle ear cleft is present with marginal perforation **(Fig. 5.4F)**.

EN 4.7: Elicit, document, and present a correct history, demonstrate and describe the clinical features, choose the correct investigations and describe the principles of management of chronic suppurative otitis media (CSOM).

Clinical Presentation of Tympanic Membrane Perforation (Mucosal Chronic Otitis Media)

Episodic ear discharge and hearing loss are the main symptoms of tympanic membrane perforation. The posterior perforations generate a more severe hearing loss than the anterior perforations. The hearing loss is seen at around 45 dB in isolated perforation. A large air-bone conduction gap (close to 60 dB) with small perforation raised the possibility of ossicular discontinuity. The loss of vibrating surface, less transmission of vibrating energy to the ossicles, and alteration of the phase difference between oval and round windows are the factors for hearing loss. The other presenting symptoms are tinnitus, vertigo, ear pain, and ear fullness. Sometimes patient presents with complicated COM. The complications of COM are discussed in Chapter 6. Tuning fork tests are performed to assess the hearing status, and it is also used to compare with the audiological outcome. The details of tuning fork tests are discussed in Chapter 16.

Investigation

Pure tone audiometry (PTA) is the required investigation to know the type degree, and pattern of hearing loss. It is also indicated for medicolegal purposes. High-resolution computed tomography (HRCT) temporal bone or X-ray Law's lateral view is advised in unsafe (atticoantral or squamous COM) pathology. Radiology helps map the dimensions of the mastoid antrum, which is the deciding factor for selecting a surgical approach—inside out or outside in. Culture is indicated in nonresponders to the standard management.

Medical Management

A dry ear is generally considered suitable for mucosal COM surgical management. The dry mopping of the ear is done by suctioning and removing debris with forceps and with the help of cotton buds. The wet mopping is done by saline irrigation. The mopping increases the effectiveness of topical medications. Examination under a microscope increases the effectiveness of mopping. An antibiotic ear drop with or without steroids is generally considered for active COM medical management. Amoxicillin with clavulanic acid is the antibiotic of choice for purulent discharge. The selection of surgical approach (myringoplasty or tympanoplasty) for

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Figs. 5.4A to F: (A) Small central perforation; (B) Medium size; (C) Large central perforation; (D) Subtotal perforation; (E) Total perforation; (F) Marginal perforation with retraction of tympanic membrane and cholesteatoma.

mucosal COM is based on hearing status. Squamous COM is managed primarily by surgical removal of disease and tympanoplasty. It is discussed in Chapter 8.

EN 4.7: Elicit document and present a correct history demonstrate and describe the clinical features, choose the correct investigations and describe the principles of management of CSOM.
EN 4.10: Observe and describe the indications for and steps involved in myringoplasty.

Outpatient Department Management of Mucosal Chronic Otitis Media

- **Chemical cauterization:** Silver nitrate and trichloroacetic acid (10%) are used for chemical cauterization of the perforation margin. It is indicated in small perforation <5 mm, where middle ear inspection is not required (dry middle ear mucosa for 3 months, no epithelial retraction, absence of sclerotic plaque at perforation margin, and AB gap <30–40 dB). It dissolves healed epithelial margin adhesion between the outer and inner layers **(Fig. 5.5A)**. Paper patch myringoplasty (cigarette paper) is described as pulling out the inward-growing margins of the tympanic membrane perforation. Three months is recommended for the final chemical cautery assessment with/without patch myringoplasty.
- **Fat myringoplasty** is the transcanal filling of the tympanic membrane defect with ear lobule fat is also performed in small-size perforations (<5 mm). Fat works as a scaffold for the growth of epithelium migration **(Fig. 5.5B)**.



Figs. 5.5A and B: (A) Chemical cauterization of perforation margin (*Courtesy:* Dr Sindhura VT, Junior Resident, AIIMS, New Delhi); (B) Fat myringoplasty.

EN 4.10: Indication and steps for myringoplasty.

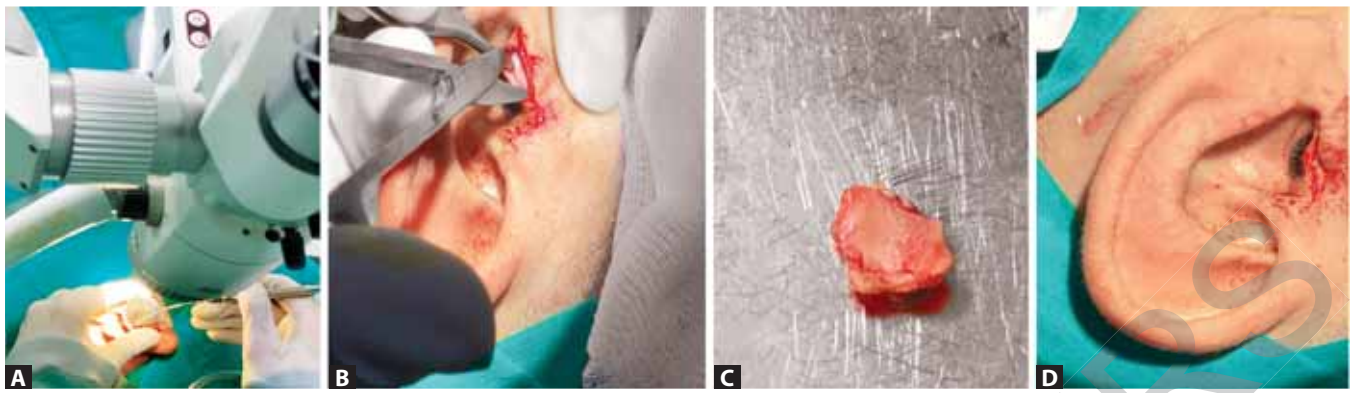
Surgical Management

The indication for myringoplasty/tympanoplasty is as follows:

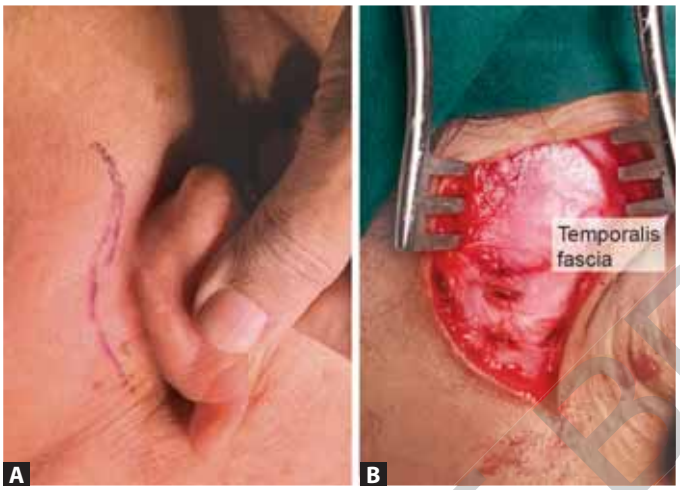
- The pars tensa perforation with hearing loss, recurrent discharge, tinnitus, and vertigo.
- Fitness for a profession like the armed forces.
- To pursue water sports activities.
- To prevent ear discharge in hearing aid users.

Repairing the tympanic membrane improves hearing by restoring the vibrating surface and creating phase differences between oval and round windows. It also protects the middle ear from environmental adulteration, creating separation

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Figs. 5.6A to D: Transcanal surgery. (A) Surgical steps mentioned in myringoplasty technique was performed via external auditory canal (EAC); (B) Tragal cartilage with perichondrium, is separated from surrounding; (C) Harvested tragal cartilage with perichondrium; (D) Tragal cartilage is reposited back after harvesting perichondrium.



Figs. 5.7A and B: Right postauricular incision (tissue is retracted with self-retaining speculum).

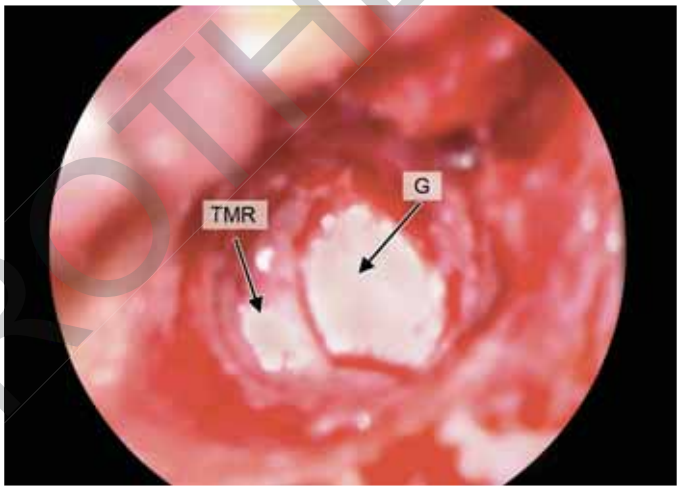


Fig. 5.8: Graft (G) is placed medial to tympanic membrane remnant (TMR).

from the external auditory canal. The tympanoplasty types are mentioned in Chapter 7.

Myringoplasty/tympanoplasty surgical techniques are classified into three types based on surgical approaches: transcanal, endaural, and postaural **(Figs. 5.6 and 5.7)**. The tragal perichondrium is mainly used for transcanal surgery, whereas temporalis fascia is used in the endaural and postauricular approaches. Endoscopic myringoplasty is the recent transcanal surgical technique.

The grafting technique is classified on the basis of placement of graft—**overlay, underlay, and interlay techniques.**

- **Underlay technique:** The graft is placed medial to the remnant of the tympanic membrane, including the annulus **(Fig. 5.8)**.
- **Overlay technique:** The graft is placed lateral to the tympanic membrane remnant. The disadvantages of overlay grafting are the blunting of the anterior tympanic sulcus, hearing loss due to graft lateralization, epithelial pearl formation, prolonged healing, and prolonged surgery time.
- **Interlay technique:** The graft is placed between the fibrous and inner layers of the tympanic membrane.

Steps of underlay myringoplasty/tympanoplasty:

- The selection of surgical approach is based on the width of the canal and the surgeon's preference.
- The perforation is examined under a microscope or endoscope.
- The debris and wax are removed, and four quadrants of local infiltration are applied.
- The edges of the perforation are freshened.
- The tympanomeatal flap is raised.
- Middle ear is examined for disease status and ossicular continuity (it is an additional step in **tympanoplasty**)
- The graft is placed and secured with gel form pieces.
- Tympanomeatal flap is reposited back in place over the graft and secured with gel form pieces.
- The wound is sutured in layers.

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- Mastoid dressing is kept for initial 1–2 days to prevent collection under the flaps.
- Suture removal is done on the 7–10th postoperative day.

Water precautions, avoiding exercise, nose-blowing, and air traveling are precautions for at least 3–6 weeks postoperative period to prevent graft lateralization. One shot of antibiotics is considered sufficient for noninfected cases.

Complications of myringoplasty/tympanoplasty are as follows:

- *Intraoperative:* Injury to chorda tympani, ossicular chain, middle ear muscles, facial nerve, perilymph fistula, vertigo, profound hearing loss, etc.
- *Postoperative:* Residual perforation, poor hearing recovery, loss of residual hearing, perichondritis, etc.

- Myringoplasty is the repair or reconstruction of the tympanic membrane.
- Tympanoplasty is the inspection of the middle ear, removal of disease, and correction of ossicular assembly with or without tympanic membrane grafting.
- Myringoplasty and type 1 tympanoplasty are not interchangeable terminologies.
- Temporalis fascia, tragal perichondrium, tragal or conchal cartilage, pseudofascia, and vein are used as grafts to repair the tympanic membrane.
- Temporalis fascia is the most preferred graft available in the same working field in abundance, high take-up rate, no additional incision required, and thickness comparable with the tympanic membrane.
- The patient who presents with anterior perforation, bilateral perforation, or large perforation, underwent revision surgery, poor Eustachian tube function, and at extremities of age are considered relatively poor candidates for surgery.
- **The absolute contraindication of surgery in mucosal COM is only hearing ear**.
- The relative contraindications for myringoplasty are the presence of cholesteatoma, refractory mucosal COM, and advanced age.

TRAUMATIC PERFORATION

Cause: Sudden modification in ambient ear canal pressure (trauma, scuba diving, barotrauma, etc.) can present with traumatic perforation of the tympanic membrane.
Symptoms: Ear fullness, hard of hearing, tinnitus, ear pain, etc.
Findings: Otoscopic examination generally shows small perforation. The margin of perforation is congested, irregular, and nonepithelialized.
Treatment: Perforation typically heals on its own within three months period. Tympanoplasty is indicated when perforation fails to heal.

GRANULAR MYRINGITIS

Granulation tissue is seen in the outer layer of the tympanic membrane, and adjacent canal wall **(Fig. 5.9)**.
Causative factor: Hot, humid environment with poor personal hygiene and repeated manipulation.



Fig. 5.9: Granular myringitis.

Symptoms: Foul-smelling discharge and otalgia.
Organisms: Gram-negative bacteria and candida are the most commonly cultured organisms.
Treatment: Antibiotic + steroid ear drop is the treatment of choice. Debridement is required when conservative treatment fails.

MYRINGITIS BULLOSA

Symptoms: Otalgia and blood-stained discharge are the presenting symptoms. It usually occurs after an upper respiratory infection (URI).
Causative organisms: Influenza virus and *Mycoplasma pneumoniae.*
Findings: The vesicles are presented between the epithelial and mesothelial layers of the tympanic membrane.
Differentials: The absence of facial nerve palsy distinguishes it from Ramsay Hunt syndrome.
Treatment: Analgesics are the only required treatment in uncomplicated cases.

TUBERCULOSIS

Routes of infection: The middle ear infection is acquired from the Eustachian tube, continuously spread from the surrounding structure, or can be blood-borne.
Symptoms: Scanty foul-smelling serosanguineous ear discharge or chronic otorrhea not responding to usual treatment are the usual presenting symptoms.
Findings: Otoscopic examination shows multiple perforations in the early stage of the disease, which can merge to form single large perforation in the advanced stage with pale middle ear mucosa and pale granulation tissue.
Investigations: Positive staining or culture for acid-fast bacilli, the presence of granulation tissue and caseating necrosis with giant cells on histopathology.
Treatment: Antitubercular therapy for a minimum period of 9 months is advisable for tubercular otitis. The added role of surgery has yet to be proven.

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SUMMARY

- The tympanic membrane is oval and pearly white. The tympanic membrane is placed obliquely at an angle of 55° with the floor of the external auditory canal. The dimensions are 10 × 9 × 0.1 mm, respectively.
- Anterior and posterior malleolar folds are present between the upper end of the tympanic sulcus and the lateral process of the malleus, which divides the tympanic membrane into two parts. Pars tensa is the more significant, tense inferior part of the tympanic membrane, and pars flaccida (Shrapnell's membrane) is a small, triangular, loose upper part of the tympanic membrane.
- It is a trilayer structure with concavity on the outer side. The outer layer is formed by stratified squamous keratinizing epithelium; the middle layer is fibrous tissue (pars propria); and the inner layer is the ciliated columnar epithelium.
- Small, large, subtotal, total, and marginal are the types of pars tensa perforation. Central perforation, safe CSOM, and tubotympanic disease are the terminologies used for pars tensa perforations.
- Atticoantral disease is traditionally used for the pars flaccida and posterosuperior pars tensa retraction, including active and inactive squamous COM.
- Pune tone audiometry ± HRCT temporal bone or X-ray Law's lateral view (squamous COM) ± pus culture are the investigations indicated in COM.
- Chemical cauterization (silver nitrate and trichloroacetic acid) and fat myringoplasty are usually performed in small size perforations.
- The indication for myringoplasty is pars tensa perforation with hearing loss, recurrent discharge, tinnitus, and vertigo. Other indications are fitness for a certain profession, such as an armed force, pursuing water sports activities, and preventing ear discharge in hearing aid users.
- Myringoplasty/tympanoplasty surgical techniques are classified into three types based on the route of the surgery—(1) transcanal, (2) endaural, and (3) postaural. The grafting technique is classified based on the placement of graft—overlay, underlay, and interlay techniques.



SELF-ASSESSMENT

REVIEW QUESTIONS

1. Explain the tympanic membrane anatomy in detail.
2. Write short notes on the following:
   a. Mopping methods for discharging ear
   b. Types of pars tensa perforations
   c. Steps of myringoplasty
   d. Chemical cautery of tympanic membrane perforation
   e. Fat myringoplasty
   f. Indications of myringoplasty
   g. Types of myringoplasty
   h. Traumatic perforation
   i. Granular myringitis
   j. Bullous myringitis
   k. Tubercular otitis
3. Prepare line diagram of the left tympanic membrane.
4. Prepare line diagram of right tympanic membrane.

MULTIPLE CHOICE QUESTIONS

1. Tympanic membrane is placed at which angle?
a. 45°
b. 55°
c. 60°
d. 70°

2. Which statement is true for chemical cautery of the tympanic membrane?
a. It is indicated for perforation >5 mm.
b. It allows adhesion between outer and inner layers of the tympanic membrane.
c. Ear drops can arrest the growth of growing edges.
d. Trichloroacetic is the drug used for chemical cautery.

3. Which of the following is not an indication of myringoplasty?
a. The pars tensa perforation in only hearing ear
b. Fitness for a certain profession like an armed force
c. To pursue the water sports activities
d. To prevent ear discharge in hearing aid users

4. Which of the following is not a step for tympanoplasty surgery?
a. Examined under a microscope or endoscope
b. Drilling out posterior canal wall
c. Freshening of perforation margin
d. Elevation of tympanomeatal flap

5. Which of the following is a grade IV attic retraction?
a. Adhesion of ossicles with tympanic membrane
b. Complete destruction of the attic outer wall
c. Attic dimple
d. Adhesion of tympanic membrane on a promontory.

6. What of the following is a grade II pars tensa retraction?
a. Distortion of the cone of light
b. Adhesion of ossicles with tympanic membrane
c. Retraction of tympanic membrane on the promontory but mobile with Valsalva maneuver
d. Adhesion of the tympanic membrane with a promontory

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7. **Which are the correct dimensions for the tympanic membrane?**
   a. 10–11 × 8–9 × 0.1 mm
   b. 9–10 × 6–7 × 0.1 mm
   c. 11–13 × 8–9 × 0.1 mm
   d. 10–11 × 10–11 × 0.1 mm
8. **Which is not a true statement for tubercular otitis?**
   a. Multiple perforations of TM
   b. Pale middle ear mucosa
   c. Pale granulation tissue
   d. Minimum duration of ATT is 6 months
9. **Which of the following statement is true for traumatic perforation of the tympanic membrane?**
   a. The perforation margin is epithelialized
   b. The perforation margin is irregular
   c. Traumatic perforation heals by its own
   d. Tympanoplasty is indicated after 3 months of conservative management
10. **Which statement is correct for the bullous myringitis?**
    a. The presence of vesicles on the tympanic membrane between the middle and inner layer
    b. Presence of facial palsy distinguishes it from Ramsay Hunt syndrome
    c. Mycoplasma pneumonia is the causative organism
    d. Prolong broad term antibiotic therapy is required

ANSWERS

1. b	2. d	3. a	4. b	5. b	6. b	7. a	8. d	9. a	10. c



INTERESTING CASES

Case 1. A male in his thirties presented with a history of the right discharging ear for 2 years. The clinical examination showed a deep retraction pocket with cholesteatoma with purulent discharge. He underwent surgery at a nearby hospital. Post-surgery, ear discharge persisted, but it was white, nonfoul smelling. The clinical picture is shown below. PTA revealed mild conductive hearing loss. **What is your next plan of action?**

Ans. Tympanoplasty



Case 2. A male in the second decade had a history of bilateral ear discharge since childhood. The clinical examination and audiological evaluation showed right ear has worse hearing than the left ear. He underwent a right tympanoplasty at the age of 17 years. The patient observed a complete loss of hearing after surgery. He came to our hospital for a second opinion. The examination showed healed perforation in the right ear with no response to tuning fork tests. The audiological assessment revealed right profound hearing loss and left mild conductive hearing loss (CHL). **What is the treatment?**

Ans. The patient was advised to take good care of another ear as the left ear is the only hearing ear.

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