Vocational Higher Secondary Education (VHSE)

SECOND YEAR

ECG & AUDIOMETRIC TECHNOLOGY

Reference Book

Government of Kerala

Department of Education

State Council of Educational Research and Training (SCERT), KERALA

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FOREWORD

Dear Learners,

This book is intended to serve as a ready reference for learners of vocational higher secondary schools. It offers suggested guidelines for the transaction of the concepts highlighted in the course content. It is expected that the learners achieve significant learning outcomes at the end of the course as envisaged in the curriculum if it is followed properly.

In the context of the Right-based approach, quality education has to be ensured for all learners. The learner community of Vocational Higher Secondary Education in Kerala should be empowered by providing them with the best education that strengthens their competences to become innovative entrepreneurs who contribute to the knowledge society. The change of course names, modular approach adopted for the organisation of course content, work-based pedagogy and the outcome focused assessment approach paved the way for achieving the vision of Vocational Higher Secondary Education in Kerala. The revised curriculum helps to equip the learners with multiple skills matching technological advancements and to produce skilled workforce for meeting the demands of the emerging industries and service sectors with national and global orientation. The revised curriculum attempts to enhance knowledge, skills and attitudes by giving higher priority and space for the learners to make discussions in small groups, and activities requiring hands-on experience.

The SCERT appreciates the hard work and sincere co-operation of the contributors of this book that includes subject experts, industrialists and the teachers of Vocational Higher Secondary Schools. The development of this reference book has been a joint venture of the State Council of Educational Research and Training (SCERT) and the Directorate of Vocational Higher Secondary Education.

The SCERT welcomes constructive criticism and creative suggestions for the improvement of the book.

With regards,

Dr. P.A. Fathima
Director
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Contents

Part A

Part B

ABOUT THE COURSE

The concept of health care in our country is gradually shifting from mortality care to morbidity care. In a country like India, with its growing population, lot of gaps exist in the health service sector. With the advent of newer strategies in the field of science and technology, cardiac medical practice has shifted considerably from clinical cardiology to laboratory oriented cardiology. This has resulted in newest investigatory techniques and procedures for diagnostic and therapeutic purposes. The risk of heart disease is on the increase now a days due to changes in life style and social set up. In these circumstances ECG and other cardiovascular measurement techniques included in the curriculum are essential for proper diagnosis. The purpose of this course is to create skilled technicians to meet the health need of society.

Hearing is one of the most important senses possessed by man. Hearing disability affects ones communicative, educational, social and emotional abilities. Audiology is the science of hearing, balance and related disorders. Early detection of hearing loss is very important for the proper management of hearing loss. The aim of the curriculum is to provide skill in clinical Audiological procedures like pure tone audiometry,speech audiometry and special tests for hearing.

Syllabus offers fundamentals to students going for Diploma in Cardiovascular Technology, Bachelor of Cardiovascular Technology, B.Sc. Audiology and Speech Language Therapy.

Major skills

- Performs the experiments related to production and propagation of sound.
- Identifies the physical and psychological properties of sound.
- Recognises of human range of hearing and development of auditory behaviour.
- Identifies the importance of test environment for audiological test.
- Identifies the anatomy and physiology of auditory system.
- Classifies hearing loss.
- Identifies the causes of hearing loss.
- Compares the various degrees of hearing loss.
- Differentiates the various patterns of audiograms.
- Identifies the different parts and functions of audiometers.
- Compares different types of audiometers.
- Performs tuning fork tests.
- Prepares case history of hearing impaired persons.

- Performs pure tone audiometry procedure.
- Analyses the results of pure tone audiometry.
- Differentiates the various patterns of audiogram.
- Familiarises speech audiometry test.
- Performs special tests of hearing.
- Identifies the procedure and clinical importance of different objective test of audiometry.
- Identifies the uses of different types of hearing aid.
- Identifies the importance of cochlear implant.
- Identifies the different types of ear moulds.

SYLLABUS

MODULE III

NAME: BASICS OF AUDIOLOGY

3.1 SOUND AND HEARING (65 Periods)

3.1.1 Definition of sound, Generation and Transmission of sound

3.1.2 Physical and Psychological attributes of sound

3.1.3 Types of sound: Pure tones, complex tones, Noise

3.1.4 Range of Human hearing

3.1.5 Development of auditory behavior

3.1.6 Sound Treated Rooms

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3.2.1 Ear - Extenal ear, Middle ear, Inner ear

3.2.2 Auditory nerve and Central Auditory Pathway

3.2.3 Theories of hearing

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3.3.1 Hearing loss, Types of Hearing Loss - Organic, Non organic Causes - Congenital vs Acquired, Prelingual vs Post lingual, Noise Induced Hearing loss, Presbycusis

3.3.2 Degrees of Hearing loss, Configuration of hearing loss, Unilateral vs Bilateral, Symmetrical vs Asymmetrical, Progressive vs Sudden hearing loss, Fluctuating vs stable hearing loss

3.3.3 Audiogram: Notations used for plotting audiograms

3.3.4 Audiogram patterns in different types of hearing loss

3.3.5 Effects of hearing loss on development

3.4 HEARING ASSESMENT (70 Periods)

3.4.1 Audiometers,Types of Audiometers

3.4.2 Pure tone Audiometer - Instrumentation

3.4.3 Case History Evaluation and its importance

3.4.4 Tuning fork Tests

MODULE IV

Module name: Basics of Practical Audiometry

4.1.1 PURE TONE AUDIOMETRY (120 Periods)

Patients and Clinicians Role in Testing - Air conduction testing, Bone conduction Testing, Plotting Audiograms, Audiogram Interpretation

4.1.2 Play Audiometry, Free field Audiometry, Aided Audiometry

4.1.3 Masking - Minimum masking, effective Masking, Over Masking, Masking Noise

4.1.4 Calibration of Audiometers

4.2 SPECIAL TESTS OF HEARING (40 Periods)

Loudness Recruitment - Short Increment Sensitivity Index, ABLB Test, Tone Decay Test

4.3 SPEECH AUDIOMETRY (65 Periods)

Need for Test Environment - Speech Discrimination test, Speech Reception Threshold, Speech discrimination score

Most Comfortable Loudness, Uncomfortable Loudness, Dynamic Range

4.4 OBJECTIVE TESTS OF AUDIOMETRY (50 Periods)

Brain Stem Evoked Response Audiometry (BERA)

Otoacoustic Emission (OAE)

Impedence Audiometry - Tympanometry, Reflexometry

4.5 HEARING AID AND EAR MOULDS (65 Periods)

4.5.1 Hearing Aids - Instrumentation, Characteristics of Hearing aids

Classification, Hearing aid selection, Care and maintenance of hearing aid, Cochlear Implants

4.5.2 Ear Mould - Types, Preparation of Ear Mould (Brief)

PART B

MODULE III

BASICS OF AUDIOLOGY

Overview

Audiology is the branch of science which deals with the study of hearing, balance and related disorders.This module deals with the basics of sound, how sound propagates, it's properties, audible frequency range of human hearing etc. It also discusses about auditory behaviour development in children. The basic concept of anatomy and physiology of human ear is very essential for audiology. This module gives a brief description about this. Depending on the site of problem in ear, there are various types of hearing loss-conductive, sensory neural and mixed type. Awareness about these types of losses and their common audiogram patterns are dealt here. Age related hearing loss, malingering and noise induced hearing loss are also discussed briefly. For testing hearing the basic instrument needed is Pure Tone Audiometer. A basic awareness about its instrumentation and parts are also needed. Thus the whole module gives us a basic idea about sound, how we hear, what is hearing loss, its types and audiometer. This is the basic step for forming a strong foundation for audiology.

3.1 SOUND AND HEARING

Overview

For the study of human hearing and hearing loss, a basic understanding of sound such as what sound is, how sounds are produced, how sounds propagate from one place to another etc are necessary. Sound can be defined as a wave of alternating and successive compressions and rarefactions in a medium of solid, liquid or gas. Sound is a typically audible acoustic wave of alternating and successive high pressure and low pressure that travels from one place to another through a medium of solid, liquid or gas. The auditory compression felt in the auditory organ when a sound is received by the ear is hearing. This unit deals with the study of production and propagation of sound, types of sound, human range of hearing, development of auditory behavior and room acoustics or sound treated rooms for hearing testing.

Learning outcomes of the unit

The learner

- Defines sound.
- Explains the generation and transmission of sound.
- Recognizes the medium for transmission of sound.
- Compares propagation of sound through different media.
- Defines the physical properties of sound.
- Differentiates gross and fine discrimination of sound.
- Defines the psychological attributes of sound.
- Differentiates the variations in intensity, frequency and duration.
- Discusses the definitions of pure tone, complex tone, musical sound and noise
- Identifies different types of sound.
- Differentiates pure tone and complex tone.
- Compares musical sound and noise.
- Explains the audible range of human being.
- Identifies the range of speech frequency.
- Differentiates the intensity range of different sounds.
- Compares the sound above and below audible range.
- Identifies the response of a child towards sound in different developmental stage.

- Compares the sound response in different developmental stages.
- Discusses the need of sound treated rooms.
- Recognizes the peculiarity of sound treated rooms.

Sound - Generation and Transmission of sound

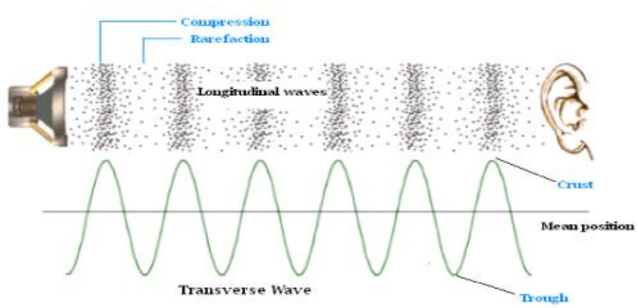
Sound

Sound is a form of energy that produces a sensation of hearing in our ears.

Generation and Transmission of Sound

For producing sound there should be a vibrating body called source. Sound is produced by a body only when it vibrates, for example - excite a tuning fork with a rubber hammer gently touch the prongs of fork with your finger, you can feel the vibration of tuning fork. Touch your throat with your fingers when you speak. You can experience the vibration of vocal cords. When it stops vibration, the sound produced by it ceases. The sound source creates vibrations in the surrounding medium. Sound waves are longitudinal waves. If the vibration of the particles of the medium are parallel to the direction of propagation, then the wave is called longitudinal wave. Eg. Snake movement along the ground. (When the particles of a medium move perpendicular to the direction of wave movement then the wave is called transverse wave. Eg. Ocean wave travelling towards the beach.)

A medium is necessary for the propagation of sound. It means that sound cannot travel through vacuum. As there is no medium on moon, one cannot hear the sound produced by another man. We cannot hear the sound of explosion taking place in the stars because of the absence of material medium in the space.



Vibrations from the sound source produce compressions and rarefactions in the medium which travel outward from its source. Compressions and rarefactions constitute a longitudinal wave progressing in the outward direction. The total length of a compression and rarefaction is called wavelength of longitudinal sound wave.

The velocity of the sound is the distance travelled per unit time by a sound wave propagating through an elastic medium. The speed of the sound in room temperature in air is 346 m/s. The elasticity and density of a medium affect sound propagation. Thus, the speed of the sound differs in different media. Sound is a vibration of kinetic energy that passes from molecule to molecule. The closer the molecules are to each other and tighter their bonds, the less time it takes for them to pass the sound to each other and the faster the sound can travel. Rail-workers sometimes put their ears to the track to make out whether the train is coming or not even when the train is not visible. They can hear the sound of the train through steel rails much before the sound reaches them through the air. This is because the speed of sound in steel is very fast (5100 m/s) in comparison to air. Sound travels slowest in gases, faster in liquids and fastest in solids

Assessment activity

Take a wooden stick and press your ears at one end of it. Ask a friend to gently knock at the other end. Are You be able to hear the sound very clearly? How?

Physical and Psychological Attributes of sound

Sound can be analyzed in two ways - Physically by using instruments to record measurements of its properties, and psychologically by listening to the sound and analyzing its properties on the basis of our immediate experience.

Characteristics of sound

Amplitude (A)

It is the maximum displacement of the particles of the medium from the equilibrium position.

Period (T)

It is the time taken by a particle of the medium to excite one complete to and fro motion.

$$T = \frac{\text{Time}}{\text{No. of vibrations}}$$

Wave Length

It is the distance travelled by the wave during one complete vibration of the particles of the medium.

Frequency (N)

Frequency of a wave is the number of vibrations executed by the particles of the medium in one second. Unit of frequency is Hertz (Hz).

$$N = \frac{\text{No. of vibrations}}{\text{Time}}$$

Intensity

The intensity of sound wave refers to the strength of a particle vibration or rate of sound energy trans missed through a medium.It is usually measured in decibels (dB). At a distance of one metre, intensity

Whisper	-	30 dB
Normal conversation	-	60 dB
Shout	-	90 dB
Discomfort of the ear	-	120 dB

Properties of sound

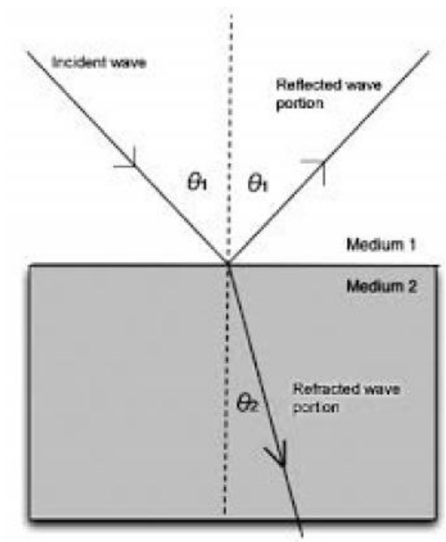
Reflection

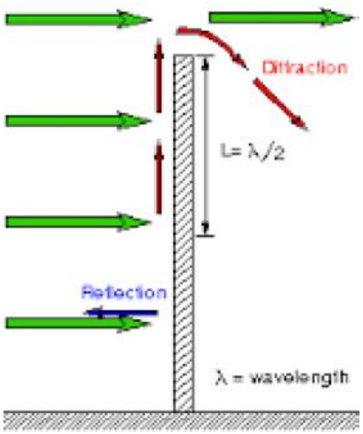
Whenever a sound wave travelling in a medium is obstructed by a hard surface, it is sent back in to the same medium. This phenomenon is called reflection.

Echo is formed as a result of reflection of sound. Ordinarily echo is not heard since the reflected sound gets merged with the original sound. A sensation of any sound persists in our ear for about 0.1 sec, after the original sound heard dies off. This is known as the Persistence of hearing. So the most important condition for hearing an echo is that the reflected sound should reach the ear only after a lapse of at least 0.1 sec after the original sound dies off.

Refraction

When a sound wave crosses the boundary between two media, its direction of propagation changes. It is called refraction.



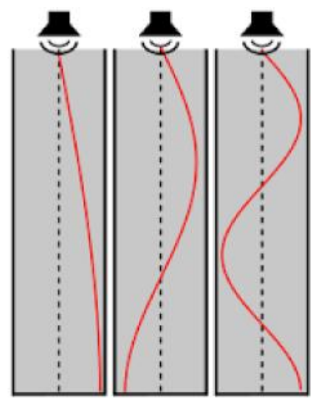


Diffraction

Any redistribution in space of the intensity of sound resulting from the presence of an object will cause variations in the amplitude or phase of sound wave. This is known as Diffraction. For example, the head of an individual causes diffraction of sound. This phenomenon is known as the 'Head shadow effect'.

Resonance

Resonance is the phenomenon of setting a body into vibrations by a strong periodic force whose frequency coincides with natural frequency of the body.



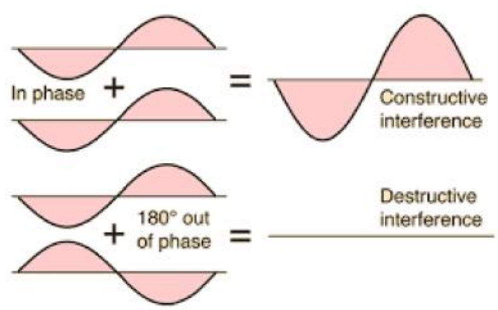
Eg: A vibrating tuning fork when placed near the mouth of a particular length of air column it produces a loud sound due to resonance.

Absorption

When a sound strikes on an object its intensity decreases due to absorption.

Interference

If two or more waves with same or nearly the same frequency are super imposed on one another, the amplitude of resultant sound is modified. When the waves are in same phase, their amplitude increases which is equal to the sum of their amplitudes (Constructive interference). When they meet in opposite phase, the amplitude becomes less being equal to the difference of their amplitude (Destructive interference).



Beats

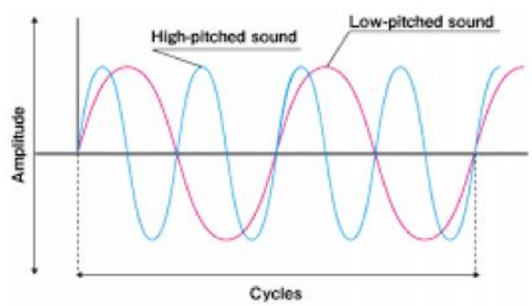
When two tones of almost identical frequency are presented (Eg: 1000 and 100 Hz) there will be a noticeable increase and decrease in the resulting sound. These changes are perceived as beats.

Psychological properties of sound

We hear different kinds of sounds in our surroundings. Each sound is different from the other. But what makes these sounds different from each other? One sound differs from each other in three fundamental particulars called a) pitch b) loudness c) quality or timbre.

Pitch

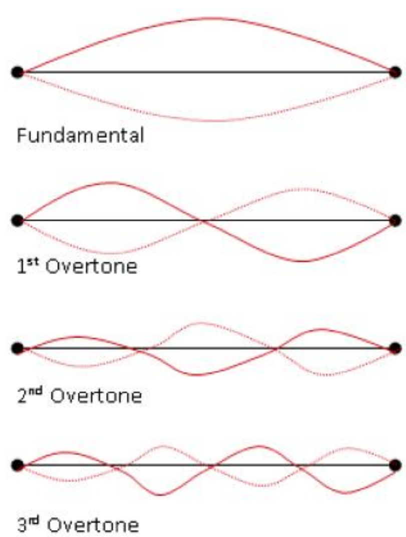
It is the shrillness of the sound felt by the ear. The voice of ladies and children are higher in pitch compared to men.



With the increase in frequency of a vibrating body, the pitch of a sound increases. So, a vibrating body having a high frequency produces a high pitch or shrilled sound and a vibrating body having a low frequency produces a flat low-pitched voice.

Pitch is different from frequency. Pitch is a subjective property depending on psychological impression and cannot be measured quantitatively whereas frequency is a measurable quantity.

Overtones: A complex tone has a fundamental frequency i.e. is the lowest frequency at which a source vibrates. All frequencies above that tone are called overtones.



Loudness

Loudness of a sound is the degree of sensation of the sound produced in the ear. i.e. the varying pressure exerted on the eardrum by the incoming sound waves. Loudness depends upon the following factors.

- Response or sensitivity of the ear for sound of that frequency.
- Loudness of a sound also depends upon the sensitivity of the ears of the listeners.
- Amplitude of vibration.

Greater the amplitude, louder the sound. For example, if the string of a guitar is plucked gently, a soft (faint) sound is heard but if it is plucked hard, it displaces more from its rest position, that is, its amplitude of vibration increases and loud sound is produced.

- Area of a vibrating body

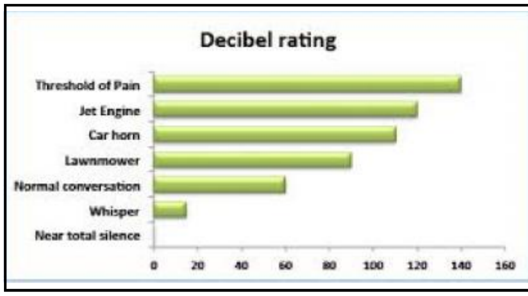
Larger the area of a vibrating body, louder is the sound produced. A large drum produces louder sound than a small drum. Church bells can be heard from a great distance because they have a large vibrating area.

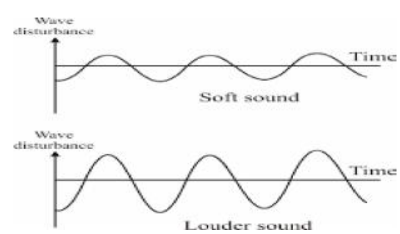
- Distance from the source

Loudness of a sound decreases with the increase in distance of the listener from the source.

The decibel scale

The intensity level of a sound can be measured in decibel (dB). The minimum loudness of a sound audible at any frequency is considered to be zero (i.e. zero dB). If the intensity increases 10 times of the reference level (zero dB), sound level becomes 10 dB. If loudness increases by 100 times, the sound level becomes 20 dB. The sensitivity of the human ear varies with frequency. The weakest sound corresponding to zero decibel cannot be heard by us. The sounds of intensity 140 decibels or more produce pain in the ear and will ultimately damage the delicate tissues. The following figure illustrates the level of sound in dB of various sounds.





Difference between LOUDNESS and PITCH	
LOUDNESS	**PITCH**
• Loudness is the property of sound by virtue of which a loud sound can be distinguished from the faint one.	• Pitch is that characteristic of sound by which a shrill sound can be distinguished from a grave or flat one.
• Loudness depends on the amount of sound energy received by the ears per unit time.	• Pitch does not depend upon the energy received by the ears.
• Loudness does not depend on frequency of a sound.	• Pitch of a sound changes with change in frequency.

Quality or Timbre

We can identify a person by his voice. How is this possible? Because each person's voice is different. The characteristic of sound which enables us to distinguish between two sounds of the same pitch and loudness, produced by two different sources is called quality or timbre.

Types of sound

Pure tone - sound with a single frequency is called pure tone sound.

Eg: Sound produced by tuning fork.

Complex tone

Sound hearing of more than one frequency is called a complex tone. In everyday life we are normally exposed to complex tones.

Eg: Music, speech

Complex sounds can be periodic or aperiodic. Periodic complex sounds repeat the component waveforms at regular interval, aperiodic sound do not repeat this.

Musical sound

When the waveforms of a sound repeats itself periodically that sound is called musical sound. Musical sound produces a smooth and pleasing effect to the ear.

Noise

Noise is a combination of sounds of irregular frequency and is unpleasant to the ear where there is no periodic repetition of the waveform of the sound.

Noise can affect our quality of life. It can hamper our ability to do daily tasks, increase fatigue, and cause irritability, noisy classrooms can make it harder for all children to learn. Just trying to hold a conversation in a noisy atmosphere requires more concentration and energy. Noise can cause changes in the body like

- Hearing impairment
- Increase blood pressure
- Change in heart beats
- Disturbed digestion
- Premature birth
- Disrupt sleep

DIFFERENCE BETWEEN MUSIC AND NOISE	
Musical sound	**Noise**
1. It is pleasant to the ear. 2. It is produced by regular periodic vibrations of a body. 3. The amplitude and frequency of vibration do not change suddenly. 4. Sounds produced by musical instruments are musical sound.	1. It is displeasing to the ear. 2. It is produced by irregular vibrations of a body. 3. The amplitude of vibration may change suddenly. 4. Sounds produced by machines, moving cars, etc. produce noise.

Assessment activity

Make a list of the sounds you like to hear and those you prefer not to hear in the table below:

Pleasant Sound	Unpleasant sound
•	•
•	•
•	•
•	•

Range of human hearing

We have leant that sound is produced as a result of vibrations. But human ear is not sensitive to vibrations of all frequencies. A normal ear can hear only sounds of frequencies ranging from 20Hz - 20000Hz. This is called Audible Range of Frequencies. Sounds of frequencies greater than 20000Hz is called Ultrasonic sounds. Though human ear cannot hear ultrasonics, some animals like dogs, bats, monkeys, deer, leopards, dolphins can hear them.

Sounds having frequencies less than 20Hz are called infrasonicsounds. Infrasonic sounds are produced by vibrating pendulum, earthquakes, volcanic eruptions, elephants, whales.

Sound of frequencies between 1000 Hz and 5000 Hz are heard best by almost all the people. For many people frequencies above 16000 Hz are not audible. Above 70 yrs at 8000 Hz audibility is low. This is why, old people find it difficult to hear when others speak.

Speech Frequencies

Frequencies of 500, 1000 and 2000Hz are called speech frequencies as most of human voice falls with in this range. PTA (Pure tone average) is the average average threshold of hearing in these three speech frequencies. It roughly corresponds to to the speech reception threshold.

Uses of ultrasonic sounds

A special whistle called **Galton's Whistle** can produce frequencies greater than 20000Hz. Dogs can be specially trained to respond this whistle.

- Ultrasonic sounds are used by fishermen to identify shoal of fish in the sea.
- Ultrasonic sound is used in sonar to measure depth of sea.
- It is used in dishwashing machines. Water and detergents are vibrated by ultrasonic vibrators to clean dirty utensils.
- It is used for homogenising milk. Fresh milk is agitated with ultrasonic vibrator to mix desired amount of fat and powder to obtain milk.
- It is used in scanning and imaging internal organs of the body.
- Ultrasonic sound is used in the treatment of arthritis and muscular pain.
- It is used to detect faults in the metal sheets.
- Dolphins also use ultrasonic sound to locate any obstacles or prey in the path while swimming in the sea.

Bats can produce ultrasonics. The ultrasonics produced by the bats return to them after getting reflected from any object. This enables them to detect any prey or obstacles in their paths

Development of auditory behaviour

In a child's early development stage they will be exposed to many new and wonderful sounds. For fully development of speech and language skills they must be able to hear adequately from the time of birth.

Birth to 3 months

Baby should startle to environmental sounds such as door slamming, dog barking etc. Many times you will see, an increase in this behaviour in the presence of their parents. This stage of babbling is because the child produces large variety of sounds with no repetition of any sound produced.


Startling Reflex

3-6 Months

Baby should begin to turn the head and lateralise sound. Babbling using different speech sounds should emerge. This is the stage of lalling. The child may start repeating his own sound and as the stage progresses the child's sound repertory gets narrowed further.

6-9 Months

Baby should turn toward interesting sounds such as voices, music, and animals. Many times a child will stop their activity when they hear a sound or name is called. Speech behaviour should start to include, more speech like sounds with greater frequency. Child starts repeating the sound he hears from outside.

9-12 Months

Child should generally hear soft sounds and whispers. They should be able to localise in every direction, high and low and left to right. Speech like sounds and jabbering behaviour will occur with greater regularity. The child like sounds are heard and it gets narrowed. More and more word like sounds are heard. By the end of this stage the child starts using very common words with meaning and enters the stage of **'true speech'**.

18 Months

Child should be able to recognize voices and different environmental sounds, and they should be able to point to and identify various objects. Their vocabulary should include a handful of words.

2 years

Child should be able to follow simple directions, point to body parts when named, hear you from another room and speak in sentences containing two and three words.

Assessment activity

Prepare a chart showing a child's response towards sound in different development

Sound Treated rooms

Objects like mirrors metals or hard objects like buildings or stones reflects sound, but materials with loose texture absorb sound. Eg: Curtains, straw, carpets etc. The walls of Cinema theatre or auditorium are coated with rough materials so that they do not reflect any sound. If echo formed the quality of sound heard by people becomes poor. Ordinary rooms in our homes are small compared to theatres. Thus the original sound and reflected sound reach the ears almost at the same time and hence no echo is formed.

It is by reflection on hard walls and by absorption in loose materials, one can control the acoustic properties of a room. Walls covered with absorptive materials 'deaden' a room and there will be no reverberation. Because of the stronger effects of absorption upon high frequencies, signals are deprived of their high frequency components and sound is muffled.

Rooms in which audiometric tests are to be conducted must be reasonably quiet. Testing must not be disturbed by neither sounds nor by those intruding from outside. Such rooms are known as sound-treated rooms. The outside walls of such rooms must contain heavy, hard surfaced shell in order to keepout extraneous noises. The inside is lined with absorptive material to keep reverberation low

Detailing of Practical Activities

1. Tuning fork experiment

Materials required

- Tuning fork of different frequencies
- Rubber hammer

2. Vibrate the fork by striking it against a rubber hammer and hold it in front of the ear canal.
   - What do you experience?
   - We hear the sound of the tuning fork
   - When you hold the vibrating tuning fork of different sizes, what do you experience?

We experience that there is a difference in quality of sound of each tuning fork.

With difference in size of each tuning fork the tuning fork may be vibrating with different periods of vibration.

Interference

- Vibration of a tuning fork produces sound.
- The tuning forks of different sizes and number produce sounds of different frequencies or qualities.

3. What happens to the sound of the vibrating tuning fork held near your canal over a long time.

The sound becomes softer and softer and becomes inaudible ultimately.

Interference

Sound is louder at the beginning and becomes softer and softer and ultimately inaudible.

4. What happens when the tuning fork is emitted by striking the hammer forcefully and then with less force.

Observation

When the tuning fork is emitted by striking the hammer forcefully the sound heard will be more intense or the sound heard will be louder.

When the tuning fork is emitted by striking with a rubber hammer with less force sound produced will be intense or softer.

Interference

When the vibrating body vibrates with more force the sound will be more intense and when vibrating body vibrates with less force the sound produced will be less intense or soft.

- Experiment showing resonance.
- Prepare a chart showing environmental sounds according to the frequency.
- Prepare a chart showing the development of auditory behaviour.
- Familarize the structure of sound treated rooms during OJT.

TE questions

1. Rooms in which audiometric tests are to be conducted must be quiet. Express your opinions.
2. Give reasons?
   - Astronauts while in space can communicate only through radio.

- Music is pleasant to hear but noise is not.
- You can recognize your friend by hearing his voice on a telephone.

3. Differentiate between
   - Pitch and loudness
   - Ultrasonic sound and infrasonic sound
4. Fill in the blanks.
   a. The range of audible sound is _______ Hz to _______ Hz.
   (25 to 35000Hz,20 to 20000Hz,13 to 15000Hz)
   b. Sound level is measured in _______.
   c. The repetition of reflected sound from a distant object is called _______.
   (Refraction, Echo, Diffraction, Interference

3.2 AUDITORY SYSTEM - ANATOMY & PHYSIOLOGY

Overview

The *ear* is the sense organ that enables us to hear. Hearing can be defined as the perception of sound energy via the *brain* and central nervous system. Hearing consists of two components: identification of sounds (what the sound is) and localisation of those sounds (where the sounds are coming from). The ear is divided into three main parts - *the outer ear, the middle ear,* and *the inner ear*. The inner ear is filled with fluid. The inner ear also contains the receptors for sound which convert fluid motion into electrical signals known as action potentials that are sent to the brain to enable sound perception. The airborne sound waves must therefore be channelled toward and transferred into the inner ear for hearing to occur. The role of the outer and middle ear is to transmit sound to the inner ear. They also help compensate for the loss in sound energy that naturally occurs when the sound waves pass from air into water by amplifying the sound energy during the process of sound transmission. In addition to converting sound waves into nerve action potentials, the inner ear is also responsible for the sense of equilibrium, which relates to our general abilities for balance and coordination.

Learning outcomes of the unit

External Ear

- Identifies different parts of the external ear.
- Explains the functions of each part.
- Lists the parts of external ear.
- Sketches the parts of tympanic membrane, pinna, auditory canal.
- Locates the tympanic membrane using otoscope.

Middle ear

- Categorizes different parts of middle ear.
- Identifies the contents of middle ear.
- Lists out the functions of ear ossicles, muscles of middle ear ligaments, blood vessels and nerves.
- Compares the middle ear cavity with the Eustachian tube.
- Explains the importance of Eustachian tube.

Internal ear

- Identifies and classify the parts of internal ear.
- Compares bony labyrinth and membrane labyrinth.
- Differentiates different parts of internal ear.
- Lists the parts and functions of vestibular system.
- Explains the mechanism of hearing.
- Compares the mechanism of Air conduction and Bone conduction.
- Explains the mechanism of sound localization.

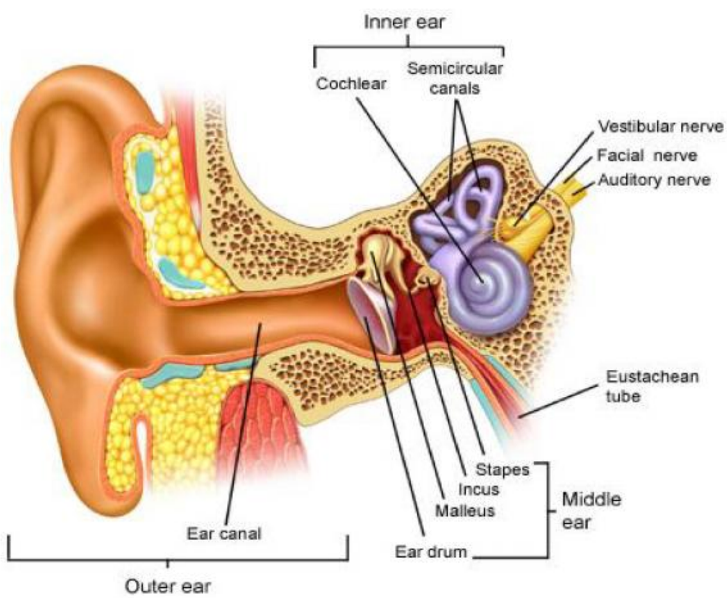
Auditory Nerve & Central Auditory Pathway

- Explains the origin and branches of vestibulocochlear nerve.
- Identifies the transmission of acoustic reflex through auditory nerve.
- Recognizes the importance of 8th nerve in hearing and balancing.
- Lists the different levels of auditory pathway.

Theories of hearing

- Explains the four different theories of hearing.
- Compares the four theories of hearing.

The Ear



The ear is an organ of hearing and balance. It is supplied by VIIIth cranial nerve (Vestibulocochlear). For the purpose of description ear is divided in to:

a. External Ear

b. Middle Ear

c. Internal Ear

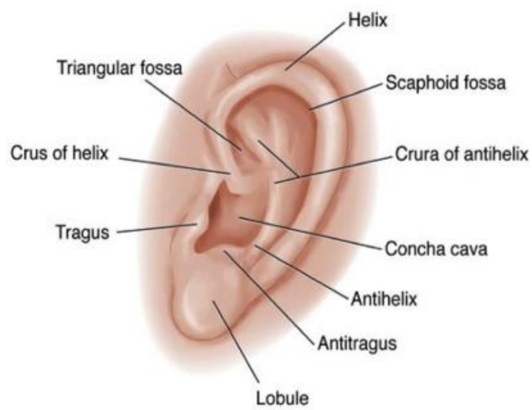
a. External Ear

The external ear consists of

i. Pinna

ii. External Auditory Meatus (Canal)

Pinnae (Auricle):



The Pinnae is the expanded portion which projects from the side of the head. It is composed of a fibroelastic cartilage covered by skin with a conical shape.The lobule is the lowest part of Pinnae which is soft pliable with out cartilage and is composed of connective tissue covered by skin.

Functions

1. The auricle is responsible for gathering sounds from the acoustical environment from a vast area and concentrate them in to the middle ear.
2. It also helps in the localization of the sound.
3. Pinnae is designed in such a way that it is more efficient in delivering high frequency sounds than low frequency sounds.

External Auditory Meatus (Canal)

The external auditory meatus conducts sound waves from the auricle to the tympanic membrane. The canal is 'S' shaped and is about 24 mm length. It has two parts:

a. Outer Cartilaginous part

b. Inner bony part

Outer Cartilaginous part

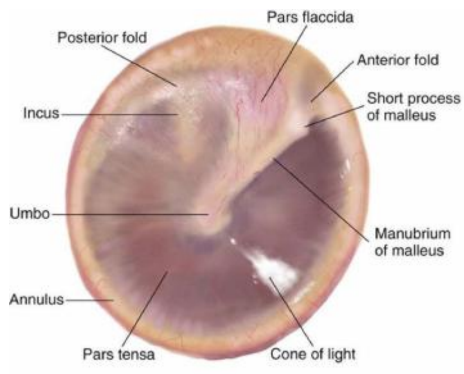
Cartilaginous part is about 8 mm of the total length. This region consists of ceruminous glands (which secretes ear wax), sebaceous glands and hair follicles. The combination of ceruminous glands and hair follicles prevent the entry of foreign objects (insects, dusts, microbes etc.) from reaching the tympanic membrane.

c. Inner bony part

It forms about 16 mm of the meatus and is devoid of hair and ceruminous glands.

Tympanic Membrane (Ear Drum)

Tympanic membrane is a thin translucent partion between the external auditory meatus and the middle ear. It is oval and conical shape in shape measuring 9 x 10mm x 0.1mm thickness. It is placed obliquely at an angle of 55 degree from the floor of meatus. The tympanic membrane is held tense by the inward pull of the tensor tympani muscle which is inserted in to the upper end of the handle of Malleus.



TYMPANIC MEMBRANE

Surfaces:

The membrane has outer surfaces and inner surfaces.

Outer surfaces:

Outer surface is concave and is lined by skin tissue.

Inner surface:

Inner surface is convex and provides attachment to the handle of Malleus which extends up to its centre. The point of maximum convexity lies at the tip of the handle of Malleus and is called umbo.

Parts of tympanic membrane:

a. Parstensa:

It is the greater part of the tympanic membrane. It has three layers - an outer layer of skin, a medial layer of fibrous tissue, inner layer of submucous tissue.

b. Parsflaccida:

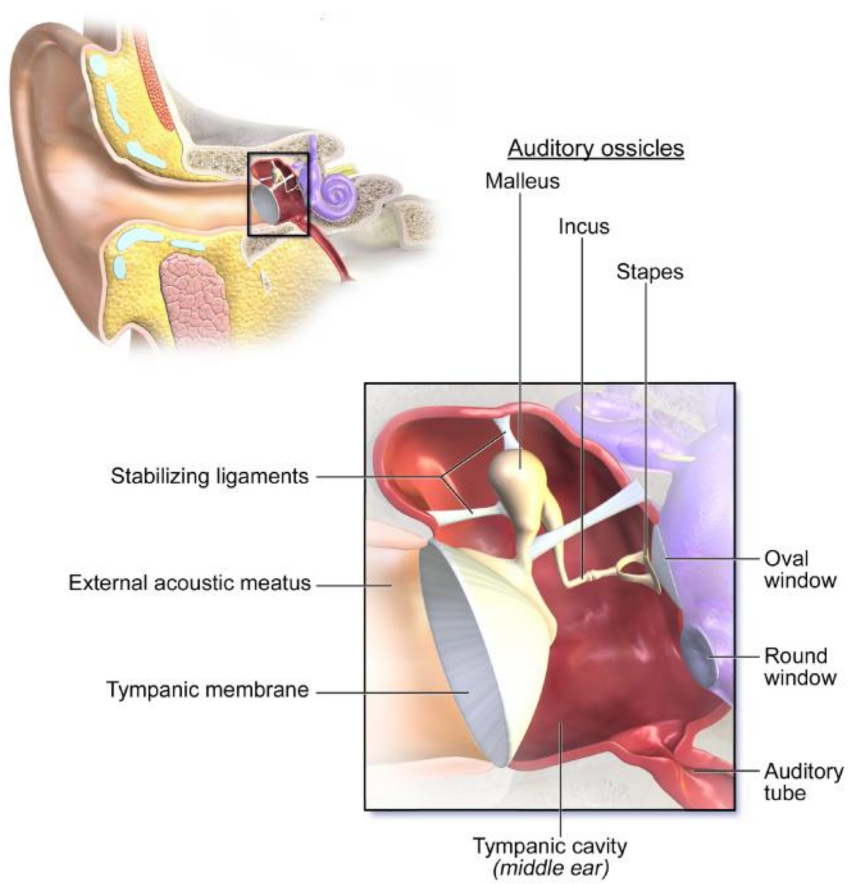
It is the upper 1/3 rd of the tympanic membrane. It has 2 layers, an outer layer of skin and an inner layer of submucous tissue.

Functions:

1. The function of the tympanic membrane is to accumulate acoustic impulses from Pinnae and direct them to the middle ear.
2. The tympanic membrane also helps in the localization

Middle ear (Tympanum, tympanic cavity)

Middle ear is a narrow air filled space situated in the petrous part of the temporal bone between the external and internal ear. It has 6 walls - an outer wall accommodating the tympanic membrane, inner wall, 2 lateral walls, a roof and a floor. The cavity is compressed from side to side and is biconcave shape. The cavity of middle ear is lined by submucous tissue and subdivided in to:



a. Tympanic cavity proper - which is opposite to the tympanic membrane.

b. Epitympanum - which lies above the tympanic membrane.

c. Hypotympanum - which lies below the tympanic membrane.

Communications: The opening of the Eustachian tube is on the floor of the tympanic cavity towards its anterior wall.

Contents of middle ear: The middle ear contents are as follows:

a. Ossicular chain:

It consists of 3 ossicles, two small muscles and a number of ligaments.

Ossicles (Malleus, Incus, Stapes)

Muscles (Tensor tympani, Stapedious muscles)

Ligaments

b. Blood vessels

c. Nerves (chordate tympani and tympanic plexus)

Functions

1. It transmits sound waves from the external ear to the internal ear through the ear Ossicles and thus transforms the airborne vibrations of the tympanic membrane to liquid borne vibrations in to the internal ear.
2. The intensity of sound waves is increased by the Ossicles. It may noted that the frequency of sound does not change.

Assesment activity

Draw and label the tympanum using the following definitions given below:

1. The part of the tympanum which is opposite to the tympanic membrane.
2. The part of the tympanum which is below the tympanic membrane.
3. The part of the tympanum which is above the tympanic membrane.
4. The lateral wall of middle ear cavity is formed by.
5. The structure in the middle ear that communicates with the nasopharynx.

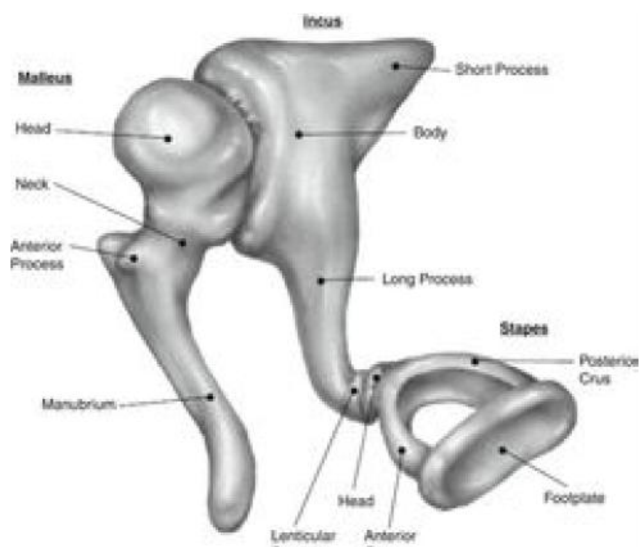
Ear Ossicles

There are three ear Ossicles.

a. Malleus

b. Incus

c. Stapes



Malleus

Malleus resembles a hammer. It is the largest and most laterally placed ear Ossicles of the ear.

Parts:

a. Round head lies in the epitympanic recess and articulates posteriorly with the body of incus.
b. The neck lies against parsflaccida.
c. The handle extends downwards, backwards and is embedded in the middle fibrous layer of the tympanic membrane.

Incus

It is so called because it resembles an anvil.

Parts:

a. The body is large and articulates with the head of Malleus.
b. Short Process.
c. Long process projects downwards just behind and parallel with the handle of the malleus.
d. Lenticular process - articulates with the head of stapes.

Stapes

Stapes resembles a stirrup. It is the smallest and most medially placed Ossicles of the ear.

Parts:

a) The small head articulates with the lenticular process of incus.
b) The neck is narrow and provides insertion to the stapedious muscle.
c) Two limbs - Anterior and posterior limbs which are attached to the foot plate.
d) Foot plate is oval in shape and is attached to the oval window.

Functions

The function of the ossicles is to pick up acoustic impulses from the tympanic membrane, subjected to the middle ear transformer action and transmit the amplified energy to the inner ear.

Assessment activity

Draw a diagram indicating the articulations of ear Ossicles.

Muscles of the middle ear

There are two muscles in the middle ear.

a. Tensor tympani
b. Stapedious muscle

1. Acoustic reflex/auditory reflex/tympanic reflex

The tensor tympani muscle attached to the handle of Malleus tenses the tympanic tympanic membrane while the stapedious muscle attached to the neck of stapes, reduces the movement of stapes . These actions of the muscles are known collectively as the Acoustic reflex. This reflex muffles the transfer of vibrations from the eardrum to the oval window.

2. Coordinating speech with hearing

The muscles of the middle ear also assist in coordinating speech with hearing, so that the sound of our own speech is not so loud as to damage our inner ear and drown out soft or high-pitched sounds from other sources. Just as we are about to speak, the brain signals the middle ear muscles to contract, dampening the sense of hearing in coordination with the sound of our own voice. This makes it possible to hear other people while we are speaking ourselves.

Eustachian tube

Eustachian tube connects middle ear cavity with Nasopharynx. In adults it is 36mm long. The upper 1/3 rd portion is (12mm) bony covered by submucous tissue and 2/3 rd is cartilaginous (24mm)covered by submucous tissue.The two portions meet an angle called isthmus.

This tube acts as an air pressure equalizer and ventilates the middle ear. The cartilaginous portion is closed normally but opens while chewing, swallowing, yawning and forcefully blowing. When the eustachian tube opens, the air pressure between the outer and middle ear is equalized. The transmission of sound through the eardrum is optimal when the air pressure is equalized between the outer and middle ear. When the air pressure between the outer and middle ear is unequal, the eardrum is forced outward or inward causing discomfort and the ability of the eardrum to transmit sound is reduced.

Impedance matching mechanism of middle ear

Two processes are involved in the impedance matching mechanism of middle ear.

They are:

1. The area of the tympanic membrane is larger than that of the stapes footplate. The forces collected over the ear drum are concentrated over a smaller area, thus increasing the pressure in oval window. The pressure is increased by the ratio of these two areas i.e. 18.75 times (telescopic transmission).

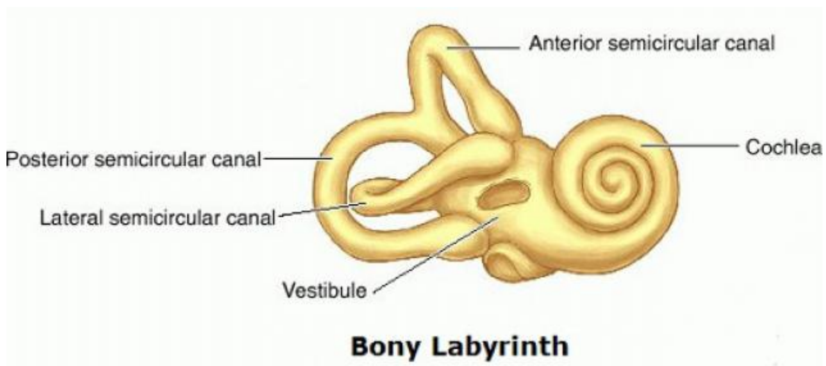
2. The second process is the lever action of the middle ear bones. The arm of the incus is shorter than that of the Malleus, and this produces a lever action that increases the force and decreases the velocity at the stapes. Since the malleus is 2.1 times longer than the incus, the lever action multiplies the force by 2.1 times.

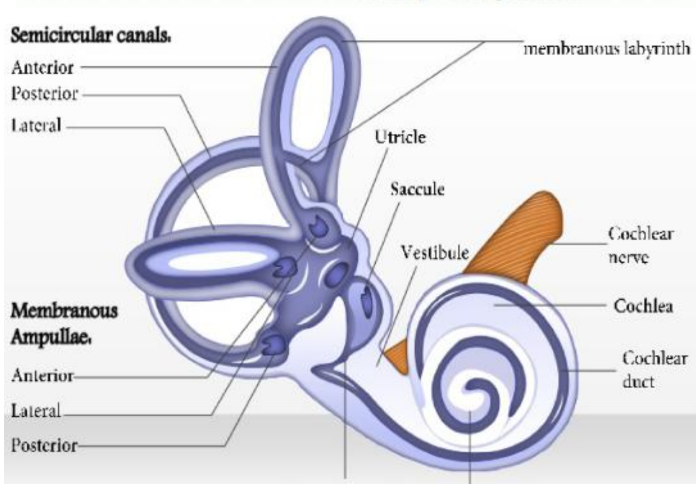
Assessment activity

Draw a diagram of middle ear and label using the following terms.

a. Tympanic membrane
b. Malleus, Incus, Stapes
c. Tensor tympanimuscle, Stapedius muscle

Internal ear





Membraneous labyrinth

It is the innermost part of ear which is responsible for sound detection and balance. The internal ear or labyrinth lies in the temporal bone. It consists of the bony labyrinth within which there is a membranous labyrinth. The bony labyrinth is a network of passages with bony walls. The membranous labyrinth runs inside of the bony labyrinth. It is separated from the bony labyrinth by a fluid called perilymph. The membranous labyrinth is filled with another fluid called endolymph.

Bony labyrinth

The bony labyrinth consists of three parts.

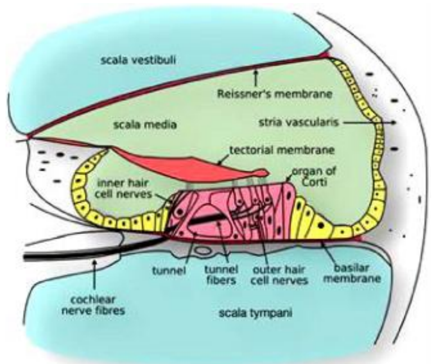
a. The cochlea

b. The vestibule

c. The semicircular canals

a. The cochlea

The bony cochlea resembles the shell of a snail. It has a conical central axis (known as the modiolus) around which the cochlear canal makes two and three quarter turns. On cross section it contains three compartments.



i. Scala vestibuli

ii. Scala media

iii. Scala tympani

i. Scala vestibuli: Scala vestibuli is above the Reissners membrane in the cochlear duct. It is filled with perilymph

ii. Scala media is in between the basilar membrane and Reissners membrane on the cochlear duct. It is filled with endolymph. The basilar membrane supports the organ of corti which is the end organ of hearing.

iii. Scala tympani: Scala tympani is below the basilar membrane of the cochlear duct .It is filled with perilymph. The scala vestibuli comes in contact with scala tympani at the helicotrema at the apex of moduolus. Scala media is a closed tube.

Function of cochlea: The function of cochlea is to convert acoustic energy into electrical impulses. The electrical impulses generated in the cochlea are cochlear potentials.

b. Vestibule

It is the central chamber of the labrynth. It lies medial to the middle ear cavity. Its lateral wall opens into the middle ear which is closed by footplate of stapes. In the posterosuperior part of the vestibule are the five openings of semicircular canals.

c. Semicircular canals

They are three in number, lateral, posterior, superior and lie in planes at right angles to one another. Each canal has an ampulated end which opens independently into the vestibule. Non-ampulated ends of posterior and superior canal unite to form a common channel called crus-commune.

Membranous labrynth

Like bony labrynth, membranous labrynth consists of three main parts:

a. Spiral duct of cochlea (organ of hearing)

b. Utricle and saccule (organ of static balance)

c. Semi-circular ducts (organ of kinetic balance)

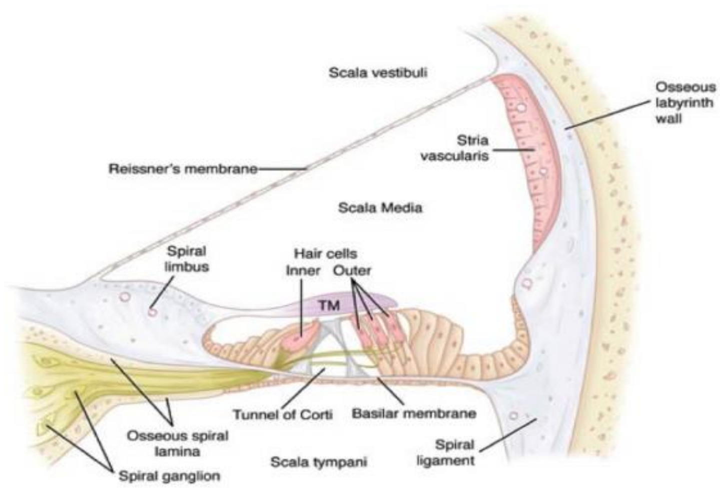
Duct of cochlea

It is also called membranous cochlea and occupies the middle part of cochlear canal between the scala vestibule and scala tympani. It is triangular in cross section. The floor is formed by basilar membrane, the roof by Reissner's membrane and outer wall by the bony wall of cochlea. The basilar membrane supports the organ of corti which is the end organ of hearing.

Organ of corti

It is situated above the basilar membrane. It moves along with the movement of basilar membrane. Important components of organ of corti are:

a. Tunnel of corti: is formed by the inner and outer rods. It contains a fluid called cortilymph.



b. Hair cells: They are important receptor cells of hearing and transduces sound energy into electrical energy. There are four rows of hair cells. A single row of inner hair cells and three rows of outer hair cells. The structure of the organ of corti and the four rows of hair cells are placed continuously in the cochlear duct from its base to apex. The hair cells at its base are attached to nerve radiations.

c. Tectorial membrane (TM): Tectorial membrane is situated in the scalamedia. It is made of jelly like substance and is electrically charged. The hair cells are embedded in Tectorial membrane.

Utricle and saccule

The utricle lies in the posterior part of bony vestibule. It receives the five openings of the semicircular canal. The duct of saccule unites with the duct of utricle to form the duct of endolymphaticus. The sensory epithelium of the utricle is called the macula. Maculae are the end organs that give information about the position of the head. They are static balance receptors.

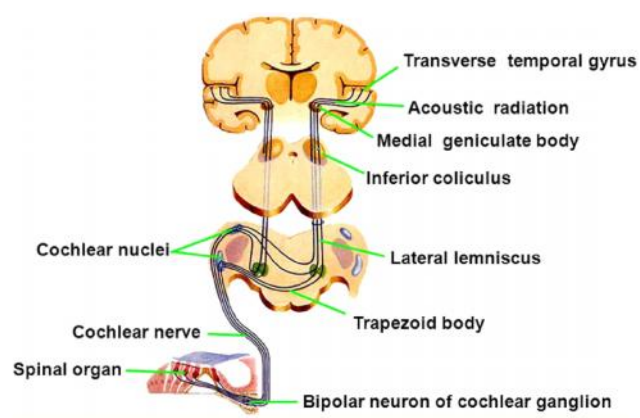
Semicircular ducts

The three semicircular ducts lie within the corresponding bony canals. Each duct has an ampulla corresponding to that of the bony canal. In each ampulla, there is an end organ called the cristae. Cristae respond to pressure changes in the endolymph caused by the movement of head.

Auditory nerve

Auditory nerve is also called 8th cranial nerve. It is formed by the bundling together of nerve radiations coming out of cochlea in the internal auditory canal. Auditory nerve ends at the brain stem.The function of auditorynerve is to receive cochlear potentials from the cochlea and transmitted to the brainstem.

Central Auditory pathway (Ascending pathway)



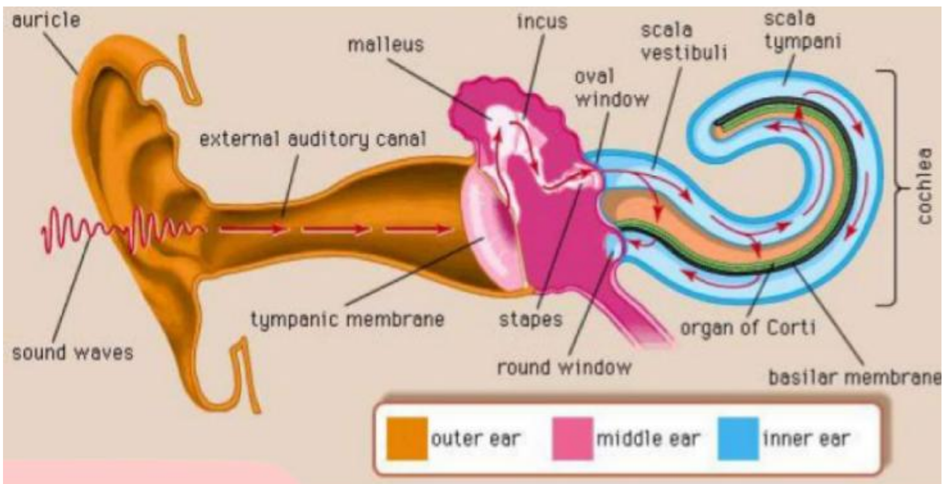
The nerve fibers of cochlea combines with the vestibule to form vestibulocochlear nerve (VIIIth CN). Further course of auditory pathway is as follows:

1. Dorsal or Ventral cochlear nuclei
2. Superior Olivary complex
3. Nucleus of lateral lemniscus
4. Inferior colliculus
5. Medila geniculate
6. Auditoy cortex

Assessment activity

Draw a block showing the structure of central auditory pathway.

Physiology of hearing



A sound signal from the environment is collected by pinna, pinna passes through external auditory canal and strikes the tympanic membrane. Vibrations of the tympanic membrane are transmitted to stapes of footplate through a chain of ossicles coupled to the tympanic membrane. Movements of stapes footplate cause pressure changes in the labyrinthine fluids which move the basilar membrane. This stimulates the hair cells of the organ of corti. It is these hair cells which act as transducers and convert the mechanical energy into electrical impulses which travel along the auditory nerve. Thus the mechanism of hearing can be broadly divided into:

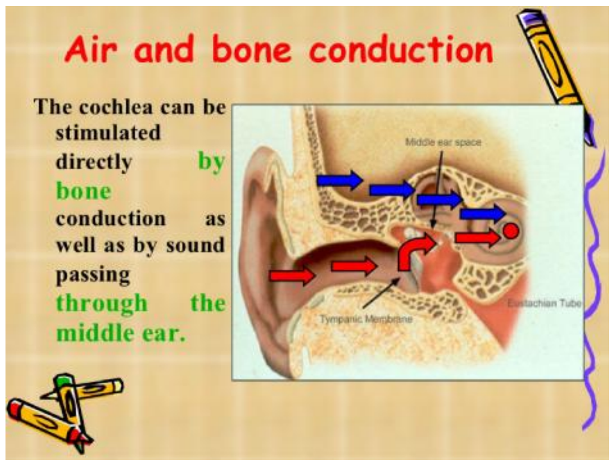
1. Mechanical conduction of sound (conductive apparatus).
2. Transduction of mechanical energy to electrical impulses (sensory system of cochlea).
3. Conduction of electrical impulses to the brain (neural pathways).

Assessment activity

Prepare a block diagram showing the conduction of high frequency sound across the ear.

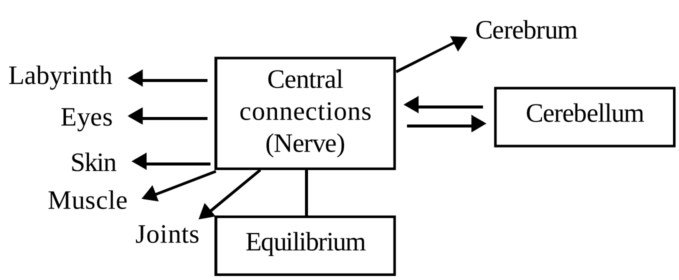
How we hear?

Air conduction is the primary mechanism of hearing.It involves carrying sound waves through the external auditory canal to the tympanic membrane. There, the sound vibrations cause the tympanic membrane and the ear ossicles to move, thus transmitting the vibrations to the inner ear structures.



Bone conduction provides an additional pathway whereby sound waves vibrate the skull bones and transmit the vibrations to the inner ear structures. Both air and bone conduction use a common final pathway involving transmission of the vibrations to the inner ear structures, then on the cranial nerve and the temporal lobe.

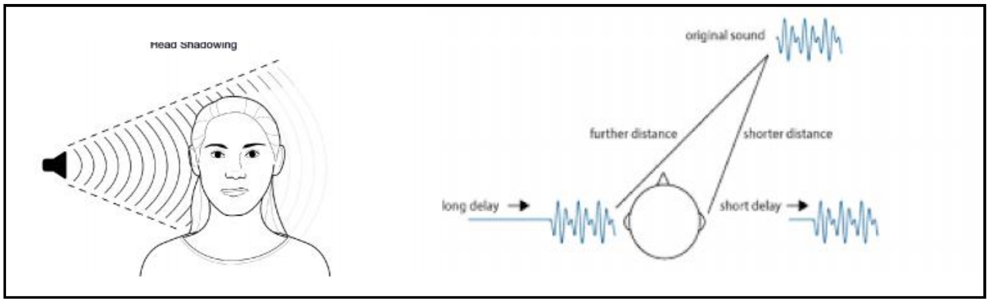
Physiology of balance



The vestibule and semicircular canals are concerned with the function of balancing (proprioceptive mechanism). Other proprioceptors of the body are muscles, joints, skin and eyes. These organs are connected to the cerebellum and the cerebrum, where the final perception of the sense of the equilibrium occurs.

Any change of position of the head cause movement in the perilymph and endolymph which stimulates the nerve endings and hair cells in the vestibule and semi circular canals. The resultant nerve impulses are transmitted by the vestibular branch of 8th cranial nerve to the cerebellum. The impulses from all proprioceptive forces are coordinated in the brain and equilibrium is maintained.

Sound Localization



Localization is the ability of a person to pinpoint a sound source. A person determines the direction from which sound emanates by two principle mechanisms

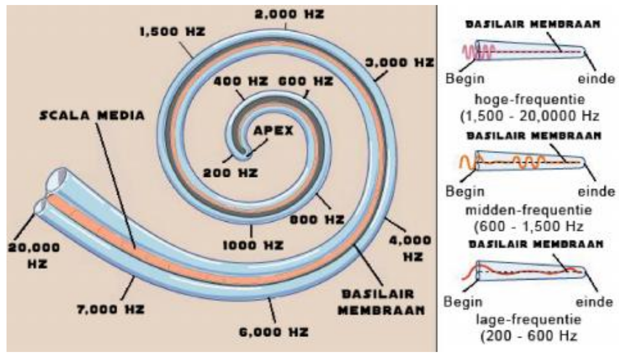
- Interaural time difference (ITD): It is the difference in time between the sound reaching both ears of the listener. If a person looking straight towards the sound, the sound reaches both ears exactly at the same instant. If the right ear is closer to the sound than the left ear, the sound signals from the right ear enter the brain ahead of those from the left ear.
- Inter aural intensity differences (IID): It is the difference in the intensity of sound reaching the two ears of the listener. This difference occurs because the head act as barrier thus causing, an acoustic shadow that prevents high frequency sounds from reaching the far ear.

The eyes also help in localization of sound.

Theories of Hearing

Place Theory: (Theory of Helmholtz)

According to this theory each pitch has its own separate place on basilar membrane. Perception of pitch depends on the separate vibration point on the basilar membrane for each frequency.



Telephone Theory:

According to Rutherfords Telephone theory the discrimination of pitch depends upon the rate of firing of individual nerve fibres and the frequency is analyzed in the central system.

Wever's Volley theory:

This theory represents a combination of both place and telephone theories. According to this theory higher frequencies are perceived by place mechanism, lower frequencies are perceived by place mechanism.

Travelling Wave Theory:

According to Von Beksey, sound waves starting at the oval window produce vibrations which travel along the basement membrane. Initially the amplitude of wave is maximum ,while travelling further onwards the magnitude decreases and dies. The maximum amplitude depends upon the frequency.

Detailing of Practicals

1. Examination of external ear and tympanic membrane using otoscope

Procedure

During an ear examination, a tool called otoscope is used to look at the outer ear canal and ear drum. The otoscope has a light, a magnifying lens, a funnel shaped viewing piece with a narrow pointed end called a speculum.

Hold the otoscope in one hand and use the free hand to pull the outer ear upward and backward. In children the auricle (pinna) should be pulled downward and backward. This straightens the earcanal and helps to see inside the ear. Hold the otoscope like a pen or pencil and use the little finger area as a fulcrum. This prevents injury if the patient turn suddenly. While you look through the otoscope, move it gently at different angles so that you can see the ear canal walls and ear drum.

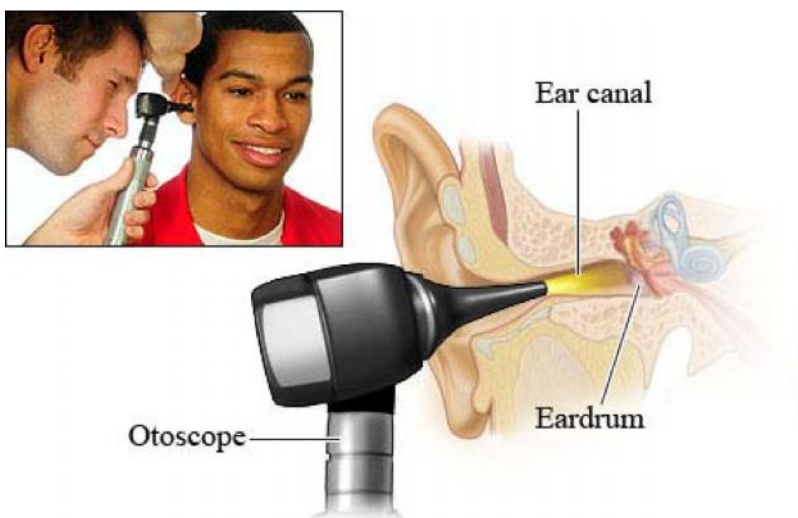
- Inspect the external auditory canal.
- Evaluate the tympanic membrane.
- Note the color (red, white, yellow) and translucency (transparent or opaque) and position (retracted, neutral or bulging) of ear drum.
- Identify the pars tensa with its cone of light and the position of malleus handle.

Normal

Auditory canal - some hair with yellow to brown cerumen.

Ear drum - pinkish grey in color, translucent in neutral position.

- Malleus lies in oblique position behind the upper part of eardrum
- Mobile with air inflation



2. Prepare coloured charts showing the structure of ear, air conduction pathway, Bone conduction pathway, Central auditory pathway.
3. Using Models identify the parts of ear.

TE questions

1. Which of the following structures is not found in the inner ear? (Cochlear Nuclei, Basilar Membrane, Organ of Corti, Semicircular canals)
2. The scientist who won a Nobel prize in 1961 for his work on sound transduction in the inner ear (William Rutherford, George von Bekesy, John Amoore, Hermann von Helmholtz).

3. The membrane that separates the scala vestibule from the scala media?
   (Tectorialmembrane, Organ of Corti, Basilar membrane, Tympanic membrane)
4. The small bony chamber of the inner ear which coils for about two and a half turns is known as the
   (Oval window, Cochlea, Semicircular canals)
5. The first structure in the brainstem to receive input from both ears is called the
   (Superior olivary nucleus, Medial geniculate body, Nucleus of lateral lemniscus, Inferior colliculus)
6. The scientist who won a Nobel prize in 1961 for his work on the basilar membrane?
7. The base of the cochlea deals with
   a) Low frequency
   b) High frequency
   c) Middle frequency
   d) None of these
8. What are the functions of the middle ear?
   a) Amplification, Protection, Impedance matching
   b) Protection, Impedance matching, Pressure Equalization
   c) Protection, Localization, Impedance matching

3.3 HEARING LOSS

Overview

This unit deals with different types of hearing losses and some of the most common causes. The aim of this unit is to develop an idea about defect in the auditory system leading to hearing loss.

Learning outcomes of the unit

- Defines hearing loss.
- Classifies hearing loss based on pathology.
- Compares different types of hearing loss.
- Analyses the different causes of conductive, sensory neural and mixed hearing loss.
- Differentiates congenital/acquired, prelingual/post lingual hearing loss.
- Defines NIHL and presbycusis.
- Compares organic and non organic hearing loss.
- Predicts the effect of hearing loss on development.
- Compares types of hearing loss based on severity.
- Classifies hearing loss based on degree of hearing loss.
- Differentiates mild, moderate, moderately severe, severe and profound hearing loss.
- Analyses different degrees of hearing loss.
- Analyses the configuration of hearing loss.
- Compares unilateral vs bilateral, symmetrical vs asymmetrical, progressive vs sudden, fluctuating vs stable hearing loss.
- Identifies audiogram and its significance.
- Identifies the notifications used for plotting audiogram.
- Compares different patterns of audiogram.
- Evaluates audiogram patterns.

Hearing Loss

Hearing loss or hearing impairment is a partial or total inability to hear and its severity may vary from mild to severe or profound. It can be due to different causes some of which can be successfully treated with medicine or surgery depending on the disease process.

Common symptoms of hearing loss

- Severe discharge from ear (otorrhoea).
- Ear pain (ear ache).
- Tinnitus (ringing sound or noise in the ear).
- Vertigo (A person feels as if they or the objects around them are moving when they are not).
- Speaking too loud/so soft.
- Increasing the volume of TV above normal level.
- Not able to follow instructions clearly.
- Difficult to understand speech in noisy situations.
- Any structural abnormalities seen in outer ear.

Classification of Hearing loss

Clinically hearing loss can be classified into two:

I. Organic hearing loss

II. Non organic hearing loss

I. Organic hearing loss

Organic hearing loss is a decrease in hearing due to anatomic or physiological abnormalities of auditory system.

Organic hearing loss can be of three types:

1. Conductive hearing loss
2. Sensory hearing loss
3. Mixed hearing loss
4. Neural loss of hearing
5. Central loss of hearing

1. *Conductive hearing loss*

In conductive hearing loss, the sound conducting mechanism is defective. This is because their cochlea would be able to recognize sound vibrations, but something is blocking the sound waves and therefore these vibrations do not reach the cochlea. As the inner ear and other sensory neural structures are normal, the hearing by bone conduction will be normal. This impaired air conduction with normal bone conduction is called conductive hearing loss.Conductive hearing loss makes sound softer and less easy to hear.This type of loss can often be corrected medically or surgically.

Congenital causes

These are abnormalities present from the birth.

a. Meatal atresia (absence of external auditory meatus)
b. Fixation of stapes foot plate
c. Fixation of malleus head
d. Ossicular discontinuity
e. Congenital cholesteatoma (an abnormal skin growth in the middle ear behind the ear drum)
f. Absence of oval window

Acquired causes

These are abnormalities developed after birth.

a. Wax or foreign body in the external auditory canal
b. Ear infections like otitis externa and otitis media
c. Tumors of external auditory canal
d. Perforated tympanic membrane
e. Poor Eustachian tube function
f. Tumors of middle ear
g. Ossicular chain dislocation
h. Collection of fluid in middle ear

2. *Sensory Loss of hearing*

It is the hearing loss due the defect or damage of cochlea.

Causes of sensory hearing loss.

Congenital causes

a. Genetic causes
b. Viral infections during pregnancy period
c. Malformation of the inner ear
d. Premature birth

Acquired causes

a. Head injury
b. Labrynthitis
c. Trauma to labyrinth
d. Viral infections

e. Intake of ototoxic drugs

f. Exposure to loud noise

g. Presbycusis (Hearing loss associated with old age)

3. *Mixed hearing loss*

When a conductive hearing loss happens in combination with sensory loss. In other words, there may be damage in the outer or middle ear and in the inner ear (cochlea)

Causes: In some advanced cases of Otosclerosis, Head trauma, middle ear tumors, chronic superlative otitis media etc.

4. *Neural loss of hearing*: It is the hearing loss due to damage or dysfunction of auditory nerve.

Causes: Tumour, Head injury

5. Central hearing loss is due to the defect or dysfunction of the central auditory pathways.

II. Non organic hearing loss

Non organic hearing loss is the hearing loss due to non obvious pathology. Non organic hearing loss can be of two types.

a. Malingering (Feigned hearing loss)

This hearing loss is due to conscious effort on the part of subject to deceive. The subject tries to use the hearing loss for the better circumstances such as legal, social or service compensation

b. Hysterical hearing loss

This type of deafness is a manifestation of hysteria.It is a subconscious wish to elevate the hearing threshold and is therefore outside the patients control.

Prelingual vs Post lingual Hearing loss

Prelingual hearing loss means hearing loss occurring before the development of language in an individual.This will be usually happen by birth or due to some reasons soon after the the birth like meningitis etc.This will affect the speech and language development of the child badly.Early identification and intervention will be essential in these cases.

Post lingual hearing loss means hearing loss that developed after the onset of language.This may be due to some accidents or diseases that happened after language development.With proper diagnosis and intervention their language development will be more effective.

Noise induced Hearing loss (NIHL)

Listening to loud noise for long periods of time can cause a permanent hearing loss by disrupting the delicate hearing system.This is called noise induced hearing loss.If the hair cells are damaged by loud noise the signals cannot be correctly interpreted by the brain. Once hair cells are damaged there is no current treatment to repair them. The resulting hearing loss is permanent.

Presbycusis (Senile deafness):

Hearing loss associated with old age, especially high frequency sounds. It is caused by structural changes in hair cells of inner ear. Presbycusis most often occurs in both ears, although not necessarily at the same time or rate. Because the loss of hearing is so gradual, people with presbycusis may not realize that their hearing is diminishing. They may have difficulty in distinguishing and understanding conversation in noisy situations.

Assessment Activity

Complete the table given below:

Conductive hearing loss	Sensory neural hearing loss
• Ear wax accumulation • • •	• Head injury • • •

Complete the table.

Conductive deafness	Defect in external and middle ear
• Sensory neural deafness	•

Degree of Hearing loss

Degree of hearing loss refers to the severity of the loss. The table below shows one of the more commonly used classification systems.The numbers are representatives of the patients hearing loss range in decibels (dBHL).

Degree of hearing loss	Hearing loss range (dB HL)
Normal	0 to 25
Mild	26 to 40
Moderate	41 to 55
Moderately severe	56 to 70
Severe	71 to 90
Profound	91+

Configuration of Hearing Loss

The configuration, or shape, of the hearing loss refers to the degree and pattern of hearing loss across frequencies (tones), as illustrated in a graph called an audiogram. For example, a hearing loss that affects only the high tones would be described as a high-frequency loss. Its configuration would show good hearing in the low tones and poor hearing in the high tones.

On the other hand, if only the low frequencies were affected, the configuration would show poorer hearing for low tones and better hearing for high tones. Some hearing loss configurations are flat, indicating the same amount of hearing loss for low and high tones.

Other descriptors associated with hearing loss are:

Bilateral versus unilateral Hearing Loss

Bilateral hearing loss means hearing loss in both ears.Unilateral hearing loss (UHL) means that hearing is normal in one ear but there is hearing loss in the other ear.The hearing loss can range from mild to very severe. UHL can occur in both adults and children.

Children with UHL are at higher risk for having academic, speech-language, and social-emotional difficulties than their normal hearing peers. This may be because UHL is often not identified, and the children do not receive intervention.

Below are some possible causes of UHL:

- Hearing loss that runs in the family (genetic or hereditary).
- An outer, middle, or inner ear abnormality.
- Syndromes such as Down and Usher syndrome.
- Illnessses or infections as CMV, Rubella.

- Head injury
- Exposure to loud noise.
- Traumatic brain injury (TBI).

Symmetrical versus asymmetrical Hearing Loss

Symmetrical means the degree and the configuration of the hearing loss are the same in each ear. Asymmetrical means the degree and configuration are different in each ear.

Progressive versus sudden Hearing Loss

Progressive means that hearing loss becomes worse over time. Sudden means that the loss happens quickly. Such a hearing loss requires immediate medical attention to determine its cause and treatment.

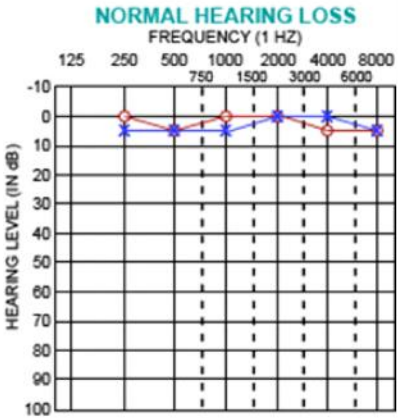
Fluctuating versus stable Hearing Loss

Fluctuating means hearing loss that changes over time. Some times getting better, Sometimes getting worse. Stable hearing loss does not change overtime and remains the same.

There is an old saying that you should not put anything smaller than you elbow in your ear. Not all old sayings are true but this one is. It is not even a good idea to use a cotton swab to remove ear wax. This can push wax deeper in your ear. Irritating the ear canal with a cotton swab can even lead to an ear canal infection. If you want to remove excess ear wax you can clean the opening of your ear by using a wash cloth. Don't put anything sharp in your ears because it can cause serious damage to tympanic membrane. Sometimes swimming can lead to a case of swimmer's ear. Do not swim in dirty water. Dry your ears after swimming and shake out excess water.

Audiogram

An audiogram is graph shows audible threshold for standardized frequencies as measured by an audiometre. In an audiogram the x axis represents frequency measured in Hz and Y axis represents intensity measured in decibels. Audiogram gives information about various thresholds of hearing, degree of hearing loss and type of hearing loss.



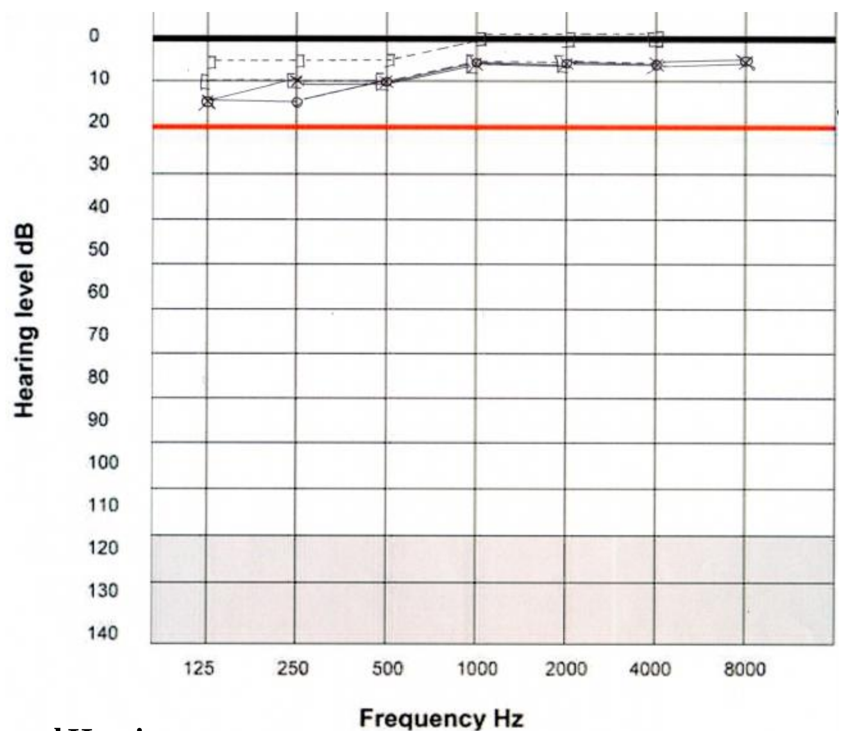
Notations used in Audiogram

Notations used for plotting audiogram are,

1. ○———○ AC right ear unmasked
2. X———X AC left unmasked
3. □———□ AC right masked
4. △———△ AC left masked
5. [................[BC right unmasked
6.]................] BC Left unmasked
7. ┌................┌ BC right masked
8. ┐................┐ BC left masked

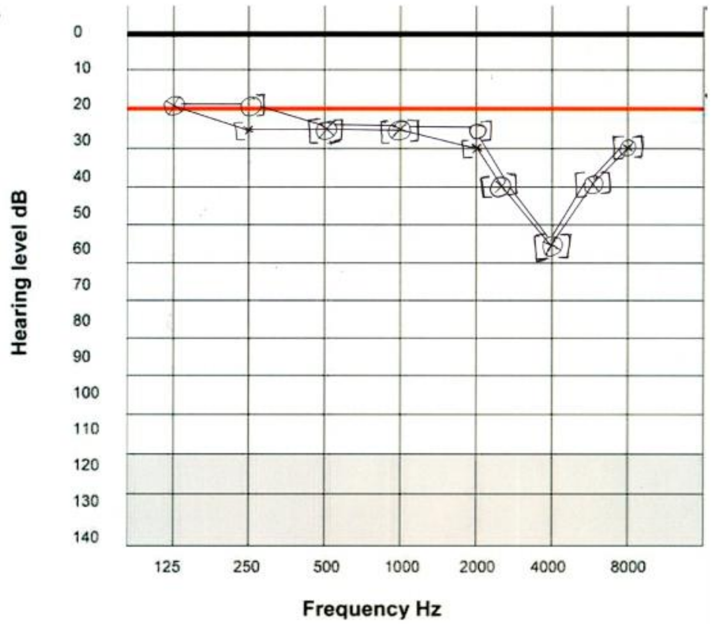
↓ Downward placed arrow below threshold notation suggests no response and the notation is placed at the available maximum intensity of the Audiometer for that frequency.

Audiogram patterns in different types of hearing loss



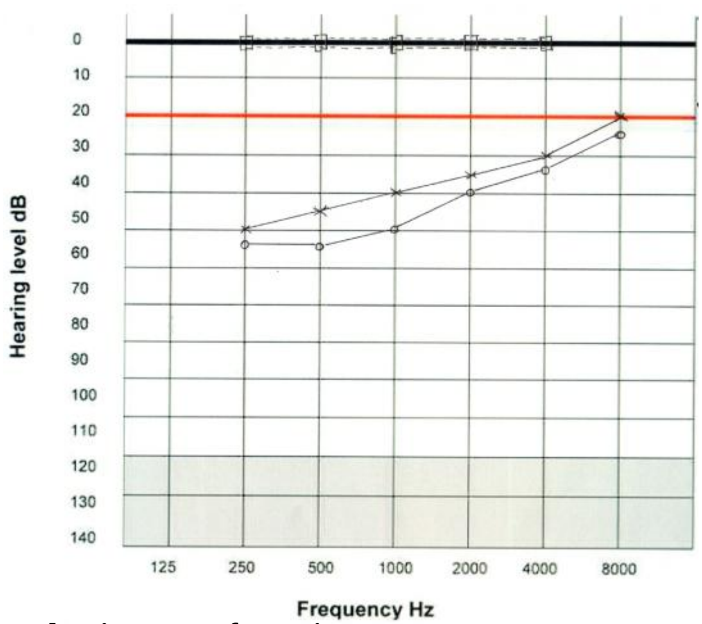
Normal Hearing

The air conduction and bone conduction thresholds for all frequencies tested shows thresholds of hearing at 0dB or upto 15-20dB is suggestive of normal hearing.



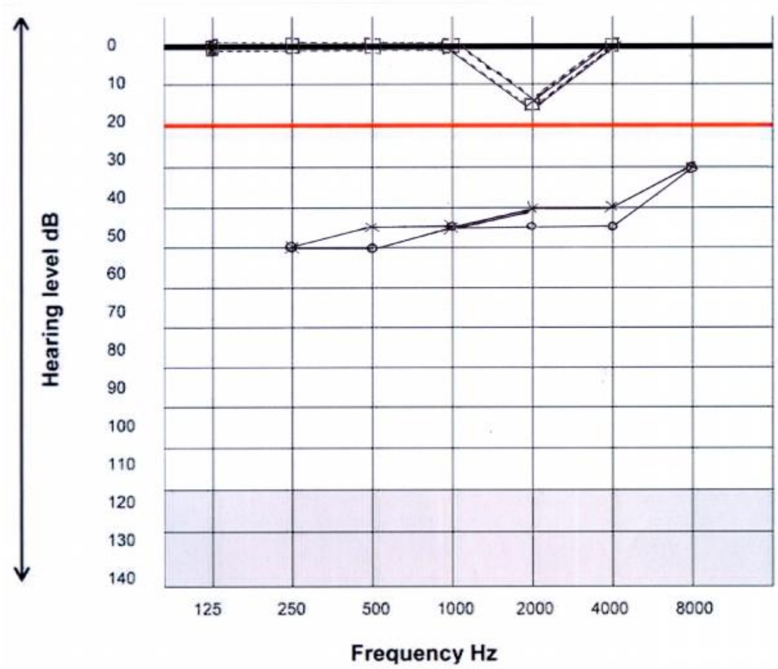
Bilateral Noise Induced Hearing Loss

Prolonged exposure to loud noise results in the threshold of 4 KHz showing a sudden dip suggestive of noise induced hearing loss.



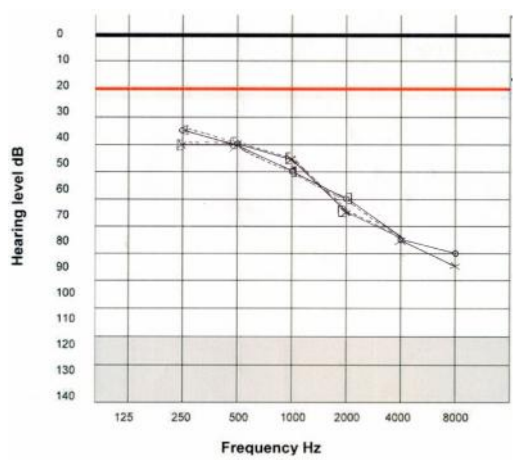
Bilateral Conductive Loss of Hearing

Conductive loss of hearing shows a loss in conductive hearing especially in the low and middle frequencies with normal bone conduction an all frequencies.



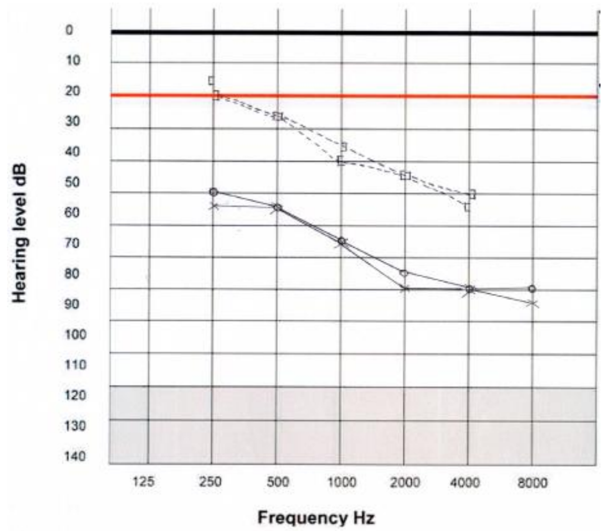
Bilateral Moderate Conductive Loss (Bilateral Otosclerosis)

Audiogram showing loss in air conduction hearing and normal bone conduction hearing on all frequencies except at 2000Hz showing a dip in bone conduction hearing of 10 to 15dB, suggestive of Otosclerosis.



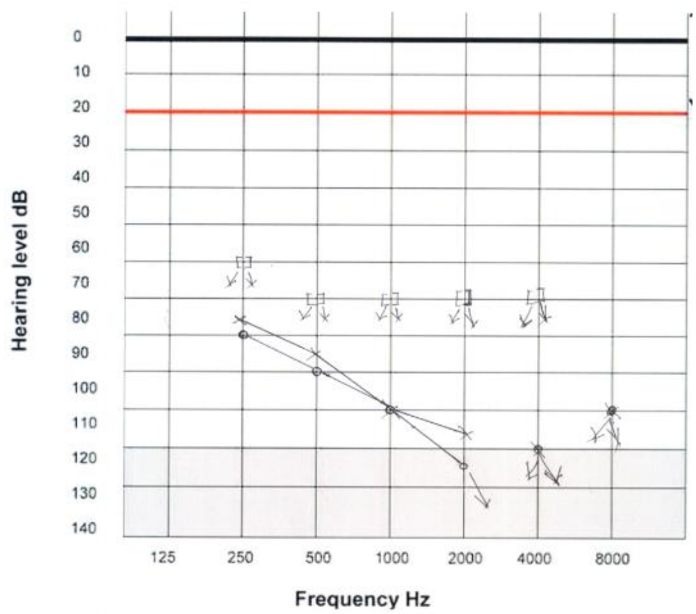
Bilateral Moderate Sensory Loss of Hearing

An audiogram showing a progressive increase in the air and bone conduction hearing thresholds which increases progressively from lower to middle and higher frequencies with an average loss of 55 dB suggests a moderate sensory loss of hearing.



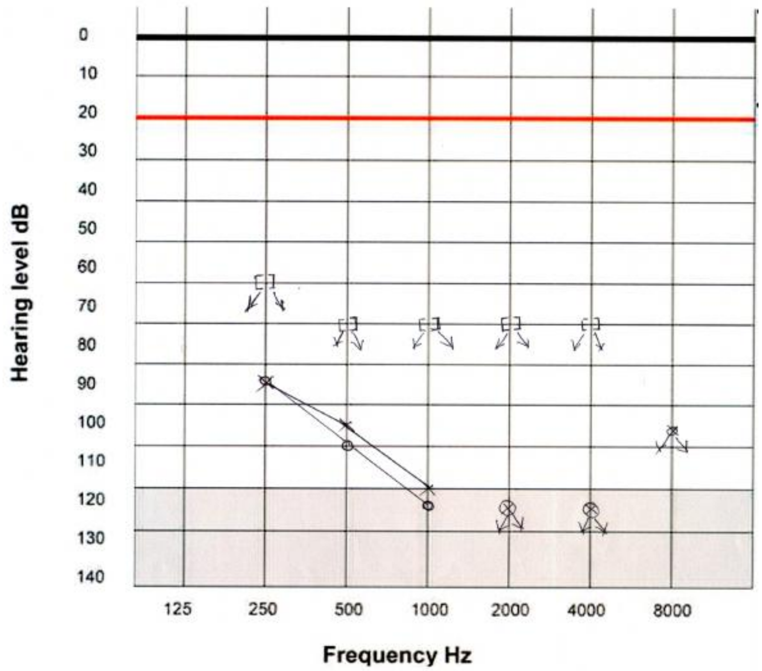
Bilateral Moderate Mixed Loss of Hearing

An audiogram showing a progressively increasing loss from low to medium to high frequencies in air conduction in air conduction hearing and a progressively increasing loss across low to medium to high frequencies in bone conduction hearing suggestive of mixed hearing loss.



Bilateral Profound Sensory Loss of Hearing

An audiogram showing some air conduction hearing in the lower frequencies and an average loss of 90 dB or more on medium and higher frequencies with no bone conduction suggest profound sensory loss of hearing.



Bilateral Profound Sensory Loss of Hearing (left corner audiogram)

An audiogram showing hearing in air conduction on low frequencies and no hearing on the middle and higher frequencies and an absent on bone conduction hearing across all frequencies shows a profound sensory loss of hearing with a left corner audiogram.

Effects of Hearing loss on development

It is well recognized that hearing is critical to speech and language development, communication, and learning. Children with listening difficulties due to hearing loss or auditory processing problems continue to be an underidentified and undeserved population.

The earlier hearing loss occurred in a child's life, the more serious the effects on childs development. Similarly, the earlier the problem is identified and intervention begun, the less serious the ultimate impact.

There are four major ways in which hearing loss affects children:

1. It causes delay in the development of receptive and expressive communication skills (speech and language).
2. The language deficit causes learning problems that result in reduced academic achievement.

3. Communication difficulties often lead to social isolation and poor self-concept.
4. It may have an impact on vocational choices.

Specific Effects

Vocabulary

- Vocabulary develops more slowly in children having hearing loss.
- Children with hearing loss learns concrete words like cat, jump, five and red more easily than abstract words like before, after, equal to, and jealous. They also have difficulty with function words like the, an, are, and.
- The gap between the vocabulary of children with normal hearing and those with hearing loss widens with age. Children with hearing loss do not catch up without intervention.
- Children with hearing loss have difficulty understanding words with multiple meanings. For example, the word bank can mean the edge of a stream or a place where we put money.

Sentence Structure

- Children with hearing loss comprehend and produce shorter and simpler sentences that children with normal hearing.
- Children with hearing loss often have difficulty in understanding and writing complex sentences, such as those with relative clauses ("The teacher whom i have for math was sick today.") or passive voice ("The Ball was thrown by Mary")
- Children with hearing loss often cannot hear word endings such as -s or -ed. This leads to misunderstandings and misuse of verb tense, pluralisation, nonagreement of subject and verb, and possessives.

Speaking

- Children with hearing loss often cannot hear quiet speech sounds such as "s", "sh", "f", "t" and "k" and therefore do not include them in their speech. Thus, speech may be difficult to understand.
- Children with hearing loss may not hear their own voices when they speak. They may speak too loudly or not loud enough. They may have a speaking pitch that is too high. They may sound like they are mumbling because of poor stress, poor inflection, or poor rate of speaking.

Academic Achievement

- Children with hearing loss have difficulty with all areas of academic achievement, Especially reading and mathematical concepts.
- Children with too mild to moderate hearing losses, on average, achieve one to four grade lower than their peers with normal hearing, unless appropriate management occurs.
- Children with severe to profound hearing losses usually achieve skills no higher than the third-or fourth-grade level, unless appropriate educational intervention occurs early.
- The gap in academic achievement between children with normal hearing and those with hearing loss usually widens as they progress in school.
- The level of achievement is related to parental involvement and the quality, quality, and timing of the support services children receive.

Social functioning

- Children with severe to profound hearing losses often report feeling isolated, without friends, ands unhappy in school, particularly when their socialization with other children with hearing loss is limited.
- These social problems appear to be more frequent in children with a mild or moderate hearing losses than in those with a severe profound loss.

Detailing of practicals:

1. Identification of different types of hearing loss from the different audiogram patterns.
2. Prepare chart showing the notations used in audiogram.

TE questions

1. Differentiate the following terms.
   a. Prelingual vs post lingual hearing loss.
   b. Bilateral vs unilateral hearing loss.
2. Prepare a chart showing the classification of hearing loss.
3. Mention the characteristics of conductive hearing loss.
4. Prepare a chart showing the symbols used in audiogram with unmasked and masked conditions.

3.4 Hearing Assessment

Over view

Hearing assessment is very important for the proper diagnosis of hearing loss and for selecting the proper hearing aid. It involves hearing evaluation using case history and doing pure tone audiometry. Pure tone audiometer is the electronic device which is widely used for testing hearing. It helps us to provide subjective information about a patient's hearing loss. It also identifies a person's ability to hear speech. There are various types of hearing tests available, including Pure tone audiometry and speech audiometry.

Learning outcomes of the unit

- Identifies the parts and functions of audiometer.
- Differentiates the different types of audiometers.
- Compares the use of screening and diagnostic audiometer.
- Collects necessary information for preparing case history which leads to diagnosis.
- Explains the importance of case history evaluation in audiometric testing.
- Predicts the need for management of the patient.

Audiometers

Audiometer is the instrument for the measurement of the hearing.

Types of audometers

The audiometers are availabie in two types. These are,

a. Subjective Audiometers

b. Objective Audiometers

Subjective Audiometers

Subjective Audiometers are audiometers that depend on the active participation of the patient, in order to obtain the results of the hearing tests conducted.

The subjective types Audiometers are:

1. Pure tone Audiometers
2. Speech Audiometers
3. Screening Audiometers

Types of pure tone Audiometers

Type 1: Clinical diagnostic pure tone audiometers with provision for pure tone air conduction, bone conduction, free field Audiometry and diagnostic special tests.

Type 2: Pure tone screening Audiometers with provision for puretone Audiometry and speech Audiometry.

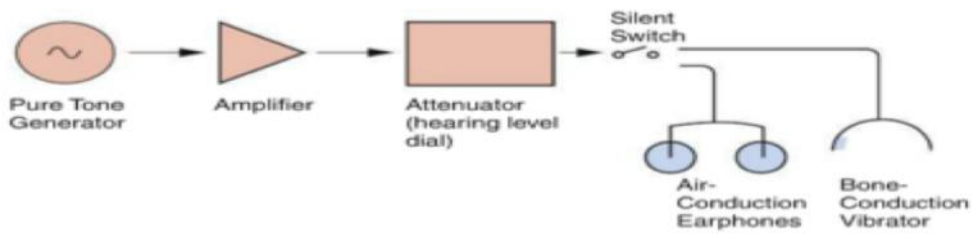
Type 3: Pure tone Audiometers with provison for pure tone testing only.

MA 53 true two channel audiometer

Puretone audiometer

Pure tone Audiometer is a diagnostic instrument used for conducting Pure tone Audiometry. It is an electronic instrument capable of producing puretone sounds of different frequencies at variable intensities.

Block diagram of pure tone audiomter



Parts of pure tone Audiometer

The parts of pure tone Audiometer are:

Frequency control: That provides the pure tones of different frequencies required for the hearing test.

Audio oscillators are available in the pure tone Audiometer to generate pure tones of required frequencies for the test.

Intensity control: To provide the test signals of the required intensities from 0 to 120 /100 dB in steps of 5dB.

Interruptor: To provide test signals for the required time for the purpose of the test when required, and withdraw it when not required.

Noise control: To provide masking noise of intensities 0-100dB in steps of 10dB.

Microphone: To provide speech, live voices etc as test signals of required intensities.

Mode selector: To select the presentation of test signals of the required intensity through head phones, bone conduction vibrator, free field speaker etc.

Function selector: Which allows selection of pure tone Audiometry, speech Audiometry, free field screening Audiometry, Special tests etc.

Head phones: Red and blue to provide the test signals by air conduction in right ear,or left ear or both ears.

Bone conduction vibrator: To provide the tests signals by bone conduction.

Masking control: To provide noise of the required intensities in steps of 5/10 dB in the non test ear as and when required.

V-U Meter: To find out when the test signal is "on" for the test and "off" when not required.It also allows to know whether the intensity of test signal is, of the required intensity itself, or it is less than or more than the required intensity.

Free field speaker: To provide the test signals in free field instead of head phones or bone conduction vibrator when required.

Objective audiometers

Objective audiometers are audiometers which provide the test results of Audiometry without the voluntary participation of the person being tested. Here the test results are machine generated and independent.

The objective Audiometers used in hearing evaluation are:

1. Brain Stem Evoked Response Audiometer
2. Oto Acoustic Emission Screener (OAE)
3. Impedence Audiometer/Middle ear anylser

Case history

Case history elicits and records all the relevant informations including personal details of the case, family history, details of prenatal, natal and postnatal history, medical history and treatments, milestones of development etc. The objective of eliciting and recording the details of case history are to pinpoint the nature, causes and the severity of handicap, the management options available for a successful treatment and rehabilitation.

Evaluation performa

Reg. No : Data :

Referred by :

Case Name : Age/Gender :

Local Address : Permanent Address :

Education : (Normal School, Special, Not Attending, Play School, LKG, LP, UP, HS, Above)

District :

Father's Name : Occupation :

Age :

Education : (Below matriculation, Matriculation, PDC, Above)

Mother's Name: Occupation :

Age :

Education : (Below Matriculation, Matriculation, PDC, Above)

Occupation :

Sibling History : (Positive, negative) Religion :

Languages Known :

Consanguinity : (Positive, Negative)

Informants :

Present Complaints :

Family History : Positive/Negative

Medical History : Positive/Negative

Ear Examination :

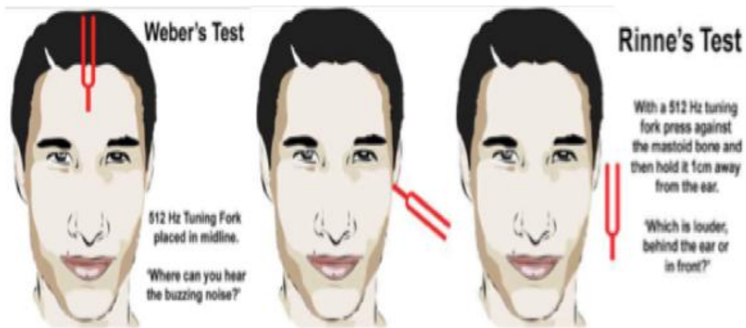
Tuning fork tests:

These tests are performed with tuning fork of different frequencies such as 256, 512, 1024, 2048 and 4096 Hz. But for routine clinical practice, tuning fork of 512Hz is ideal. Forks of lower frequencies produce sense of bone vibration while those of higher frequency have shorter decay time and are thus not routinely used.

The clinically usefull tuning fork tests include:

1. Rinne's Test
2. Weber Test
3. ABC test

Rinne's test (Sir Adolf Rinne 1855)



A vibrating tuning fork is placed in front of the ear canal for testing AC. Instruct him to tell the examiner when he stops hearing. It is then transferred to the mastoid process for BC test. Normally the person can hear more time in AC than BC. This is because air conduction is better than BC. This is called Rinne's positive (which is normal). In conductive deafness bone conduction is better than air conduction (Rinne's negative). In neural deafness air conduction and bone conductions are decreased, but still air conduction is better than bone conduction.

False Rinne negative:

When a person has unilateral severe sensory neural deafness his bone conduction and air conduction are markedly reduced on diseased side. But the patient indicates good hearing in affected ear. This is called false Rinne negative. It is due to crossing of sound from affected ear to the normal ear through the skull vibration and patient really hears through the opposite normal ear. This can be avoided by masking.

Weber test

A vibrating tuning fork is placed over the vertex or forehead of the patient. A normal person can hear the vibrations in both ears equally. In conductive deafness, it is better heard in affected ear or Weber's is lateralized to affected ear. In neural deafness, it is better heard in better ear or Weber's is lateralized to normal ear.

ABC test

A vibrating tuning fork is kept over the mastoid process of the patient. Instruct him to tell when he stops hearing. Immediately transfer the tuning fork on to the examiners mastoid process and check whether he can receive any sound. Here it is assumed that the hearing power of examiners is normal.

Interpretation of tuning fork test results in different types of hearing loss.

Tests	Normal	Conductive Loss	Sensory Neural Loss
Rinne	AC>BC (Rinne positive)	BC>AC (Rinne negative)	AC>BC
Weber	Not lateralized	Lateralized to poorer ear	Lateralized to better ear
ABC	Same as examiner's	Same as examiner's	Reduced

Detailing of practical activities

Tuning fork test

Rinne's Test

Principle : This test compares the duration of air conduction and bone conduction of the same ear.

Materials required : Tuning fork having 512 Hz.

Procedure : The tuning fork is set in to vibration by striking it against a rubber hammer. It is then placed in front of the ear canal for testing air conduction. When the patient stops hearing the handle of the tuning fork is pressed on the mastoid prominence. Ask the patient to compare the duration of sound heard by AC and BC.

Interpretation :

Observation No: 1

The case fails to hear the sound again after he stopped hearing the sound from in front of the ear canals _______ Rinne's Positive.

Observation No: 2

The case resumes hearing the sound again after he stopped hearing from in front of the ear canal and pressed against the mastoid bone. Then the test indicates conductive hearing loss _______ Rinne's negative.

Weber test

Principle : Weber test compares BC of the two ears. It is particularly useful for testing unilateral deafness.

Procedure : The test is performed by placing the foot plate of a vibrating tuning fork at the vertex of the Skull. The patient is asked in which ear the sound is heard.

Interpretation :

Observation No: 1

Weber is heard in the Poorer ear? The poorer ear has conductive loss.

Observation No: 2

Weber is lateralized to better ear? The poorer ear has sensory neural loss.

Observation No: 3

Weber is heard in Midline? Both ears have equal loss.

Absolute bone conduction test

Principle : This test compares the ABC of the patient with that of the examiner, assuming that the examiner has normal hearing. Thus one can detect sensory neural deafness in a patient.

Procedure : For testing ABC the ear canal is blocked by a finger. The vibrating tuning fork is placed on the mastoid of the patient. As soon as he stops hearing, it is transferred to the mastoid of the examiner after closing his ear canal.

Interpretation :

Observation No: 1

a) The tester doesn't hear the tuning fork sound after the patient stopped hearing sound-Normal hearing.

b) The tester continues to hear the tuning fork sound after the case stopped hearing the sound for a period of counting up to 'x' (where 'x' will be a number. Eg: 1, 2, 3, 4, and so on.
The patient has hearing loss of reduced 'X' numbers.

2. Identify the parts of audiometer.
3. Familiarize the format of case history.
4. Preparation of case history under guidance.

TE questions

1. Prepare a comparison chart showing the interpretation of tuning fork test in case of normal, conductive and sensory neural deafness.
2. Differentiate the following terms.

   a) Screening Audiometer b) Diagnostic Audiometer c) Clinical Audiometer
3. In case of unilateral sensory neural deafness the result of rinne's test may be false negative.
   a) Explain the mechanism of false rinne negative.
   b) Mention any one method to overcome the false Rinne negative in this case.
4. List out the types of audiometers.

Extended activities

1. Prepare a seminar on the impact of noise pollution.
2. Visit an Audiology Lab and prepare a note on the structure of sound treated room.
3. Prepare a power point presentation about the structure of ear.
4. Observe the voice quality in the speech conductive and sensory nueral hearing loss.
5. CollectIion of case histories of different types during OJT.

List of practicals

- Experiment showing generation and transmission of sound-Tuning fork experiment.
- Experiment showing resonance.
- List out the environmental sound according to the frequency.
- Observation of different responses to sound in infants.
- Familiarize the structure of sound treated rooms.
- Preparation of coloured charts.
  - AC pathway
  - BC pathway
  - Structure of ear
  - Central auditory pathway
- Identification of different parts of auditory system using models.
- Examination of external ear & tympamic membrane using otoscope.
- Observe the voice quality in the speech of conductive and sensory neural hearing loss.

- Identification of different types of H.L from given audiogram pattern.
- Identification of different parts of audiometer.
- Charts and model preparation based on audiometer block diagram.
- Performing tuning fork tests:
  - Rinne's test
  - Weber test
  - ABC Test
- Familarize the format of case history.
- Observation of case history.
- Collection of case histories of different types during OJT.
- Preparation of case histories under the guidance of experts.

Module 4
Basics of Practical Audiometry

Overview

Hearing testing is very important for identifying hearing loss and for the proper rehabilitation. After getting information about the basics of audiology, there is a need to develop skill in practical audiometry. Practical audiometry involves a battery of tests. This includes basic tests and special tests. Audiological test methods, like various other clinical investigations, can be categorised into behavioural, subjective and objective techniques. The behavioural and subjective classes are often grouped as one.

Behavioural methods involve monitoring the patients' reactions to auditory stimuli. The response may be involuntary, Eg: when using the distraction technique an infant will instinctively turn to locate a sound of interest. It may also be voluntary.

Subjective methods require the patient to volunteer a response, such as in pure tone or speech audiometry.

Objective hearing tests require only passive co-operation from the participant. These tests which may be performed to gain insight into the potential causes of the abnormality include, tympanometry, otoacoustic emissions screening (OAEs)and electophysiological testing (BERA).

This module gives us basic awareness about these audiological tests.

Once hearing loss is identified, next step is rehabilitation. In case if surgical or medical treatment is not effective, then the audiologist will suggest hearing aid. Hearing aid technology has advanced considerablys that, they are available in a wide variety and range. There are permanent implants like cochlear and middle ear implants, which actually replaces the lost function of ear. For proper fitting of hearing aids, particularly for Behind The Ear (BTE) type, an ear mould is essential. An earmould is a device worn inserted into the ear for sound conduction or ear protection. Thus this module gives information about various audiological tests, hearing aids, cochlear implants and ear moulds.

4.1 Puretone audiometry

Over view

Pure Tone Audiometry is an important investigation for auditory dysfunction. It not only gives an idea about the hearing handicap and the degree of hearing loss but it is also a valuable method for diagnosing ear diseases. Pure tone audiometry is a subjective method for the assessment of hearing loss.The procedures undertaken in this study involves air conduction and bone conduction testing, free field screening and play audiometry. Masking procedures that are adopted in PTA are to ensure that the thresholds obtained by PTA are of test ear itself. The calibration procedures are instrumental and biological, which ensures that the hearing measurements undertaken are carried out in exact measures.

Learning outcomes of the unit

Puretone Audiometry

- Recognizes the strategies adopted in pure tone testing.
- Chooses the frequency intensity method for test procedure.
- Explains the method of placing headphone for pure tone testing.
- Experiments the strategies for air conduction and bone conduction testing.
- Records air conduction and bone conduction threshold.
- Analyzes the air conduction and bone conduction threshold obtained.
- Records audiograms using the symbols.
- Writes the interpretation of the results of pure tone audiometer.

Masking

- Defines masking.
- Identifies the need of masking.
- Differentiates minimum masking, effective masking and over masking.
- Practices masking in laboratory.

Calibration of Audiometers

- Identifies the need of calibration.
- Performs calibration of audiometer.
- Explains calibration of audiometer.

Patients and Clinicians Role in Testing

Patient information: The examiner must establish a good rapport with the patient before the test begins. This will enable the examiner to obtain a reliable case history and to study the patients communicative behaviour. Overall impairment of the patient can be made by varying the vocal intensity during questioning.

Ear canal examination: The ear canals are not to be occluded with debris such as cerumen or cotton. This should be confirmed by the examiner, using an otoscope.

The examiner should trained in this procedure so that the tympanic membrane can be visualized easily and quickly.

Instructions to the patient:

The examiner must make sure that the following points are clearly understood by the patient.

a) The aim of test is to find out the faintest tones the listener can hear.

b) The different tone pitches are heard in only one ear at a time.

c) An immediate physical response should be made each time a tone is heard, even when very faint.

d) The motor response should cease immediately after tone cessation.

Response Strategy

The patient must raise and lower the forearm/hand/finger or use a patient signal switch that activates a light visible to the examiner.

Ear phone placement

a. The patient must remove eye glasses, ear jewellary, hearing aids or chewing gum.

b. The position of ear phones are maximally extended on the head band before placement to provide adequate room for the patients head.

c. The head phones are placed according to the universal colour codes (red for right ear & blue for left ear).

d. Ear phones should not be hand held during the test because the pressure and position can easily vary over time, and also an undesirable low frequency energy can be transmitted to the ear canal through contact with the hand.

Ear selection

The test should begin with the ear that appears more sensitive.

Frequency selection

Threshold test usually begins at 1000 Hz because of following reasons.

a) Pitch familiar to most listeners.

b) Test retest reliability is maximum at 1000 Hz.

Listener position

If threshold tests are conducted in single room, the patient must be seated in such a way that movements of the examiner cannot be directly observed by the patient, but those of the patient are visible to the examiner.

Puretone audiometry (Huggson-Westlake procedure)

Aim

- Whether the subject has a definite hearing loss.
- Whether hearing loss is conductive/sensory neural/mixed type.
- In sensory neural hearing loss whether the deafness is cochlear or retro cochlear.
- To note the degree of dysfunction.

Principle: Pure tone threshold audiometry is the standard behavioural procedure for establishing auditory Sensitivity. Air conduction test is done by head phones and bone conduction test by bone vibrators. The comparison of air conduction and bone conduction threshold provides a fundamental index of auditory function for otologic diagnosis. Here the ability of the patient to hear the pure tones in the frequency range of 250 to 8KHz is measured.

Instructions given to the Patient:

1. The different tone pitches will be heard in one ear at a time.
2. An immediate response should be made each time a tone is heard, even when very faint or barely perceptible by raising the index of the side on which the sound is heard. The responses are mandatory every time the test tone is heard.
3. The motor response should cease immediately after cessation of the test signal.

Listener familiarization:

Initial presentation at 30dB for every listener. If the tone is heard the test is begun. If not the tone is presented 20dB higher. If still inaudible a 10dB increase is recommended until a response is obtained.

Procedure:

Evaluate the case history:

1. Switch 'ON' the audiometer and keep for some time.
2. Ear phone placement.

- Should be placed according to the universal colour codes (Red for right and blue for left ear).
- The cushion should cover the entire pinnae.
- The centre of the head phone should be directly opposite to the opening of the ear canal.

3. Pure tone audiometry begins by testing the frequency of 1KHz. The ear that tested first is the right ear unless the left ear has more hearing than the right ear.

4. The intensity of the test signals are to be increased insteps of 5dB and it is lowered insteps of 10 dB.
5. After establishing the thresholds of 1KHz the thresholds are established for frequencies 2K, 4K, 6k & 8k in that order. After establishing the threshold of 8K the threshold of 1KHz is repeated to ascertain "test reliability". If the repeated threshold obtained is the same or with in +/- 5dB level the newly obtained threshold, is accepted as the threshold of 1k. After repeating the thresholds of 1KHz, the thresholds of 500 & 250 Hz are also established. (In case the newly obtained threshold of 1KHz shows a variation beyond +/- 5dB, the head phones have to be removed and the patient has to be instructed again and then the whole procedure has to be repeated.)

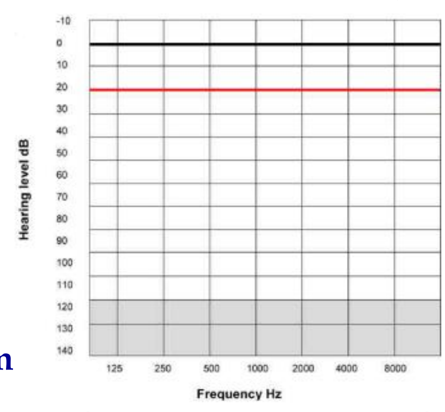
After obtaining the thresholds of the ear tested first, the thresholds of the other ear are established for frequencies 250, 500, 1K, 2k, 4k, 6k & 8KHz in that order. The minimum intensity at which 65% or more positive responses are obtained on 3 repeated presentations is accepted as the threshold of that frequency of that ear.

Bone conduction test

For Bone conduction testing a bone vibrator with headband is used. The bone conduction vibrator is placed on the mastoid bone at the point at which a steady loud tone is heard with maximum loudness. The head band is adjusted to hold the vibrator at this point. For testing bone conduction thresholds, the frequencies tested are 250, 500, 1K, 2K & 4KHz only. The thresholds are established in the same way as in the case of AC thresholds. BC thresholds of both the ears are established.

Audiogram

The thresholds obtained by AC and BC are plotted in an audiogram blank with frequency along 'X' axis and hearing loss expressed in dB along 'Y' axis by making use of appropriate notations.



Audiogram Blank

Notations used for plotting audiogram

Notations used for plotting audiogram are:

1. ○———○ AC right ear unmasked
2. X———X AC left unmasked
3. □———□ AC right masked
4. △———△ AC left masked
5. [................[BC right unmasked
6.]................] BC Left unmasked
7. ┏................┏ BC right masked
8. ┓................┓ BC left masked

↓ Downward arrow placed below the threshold notation suggests no response and the notation is placed at the available maximum intensity of the Audiometer for that frequency.

Pure tone average (PTA)

Pure tone average (PTA) is the average of thresholds of 500, 1000 and 2000 Hz of the ear concerned.

PTA = threshold of 500 + 1000 + 2000Hz/3

Interpretation:

Normal: Normally both Ac curves and BC curves superimpose in the graph at intensities 0 to 20 dB.

Conductive deafness

The conductive deafness is due to malfunction of external and/or middle ear. The cochlea is not affected. (Conductive loss will show a loss of hearing by air conduction only and bone conduction will be normal (Air-Bone gap is present).

Sensory neural loss

In this type of hearing loss, the defect lies in cochlea and neural pathways. The bone conduction thresholds and air conduction thresholds are equal and there will be loss in air conduction and bone conduction.

Mixed hearing loss:

The hearing loss affects both air and bone conduction hearing, but the hearing loss for the air conduction will be more than the loss in bone conduction.

Free field Audiometry

Free field audiometry is conducted by using a freefield speaker as outputdevice for the presentation of test signals,instead of the headphones or bone vibrator. It is conducted especially in children who refuse to put on head set for the hearing test. The test signals are received by the children in free field and the clinician evaluates the effect of presentation of test signal in the child by making note of the childs overt behaviours such as "a listening attitude", cessation of activity", overt responses such as turning of head towards the source of sound, cry and startle responses, responses of happiness and enjoyment etc.

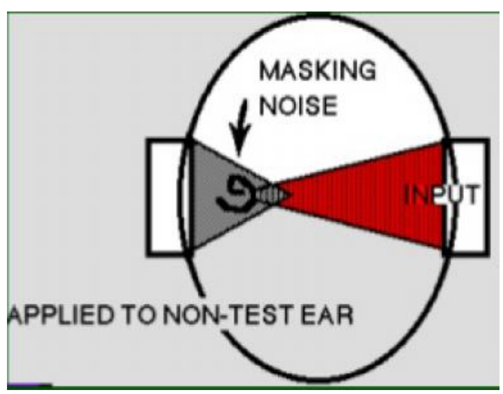
Play Audiometry

Play audiometry is the term used when pure tone testing is carried out in young children, usually up to the age of 8 years, by eliciting play oriented activities in response to auditory stimuli. Conventional methods involve voluntary overt responses of the child in response to the test signals presented through head phones or bone conduction vibrator. In play audiometry, the child is taught to respond to the test signal by carrying out a specific game, every time they hear a sound. By treating audiometry as a game the younger Childs motivation and concentration are improved, as a result of which the results obtained are both reliable and extensive.

Aided Audiometry

Aided audiometry is the audiometry conducted in persons with hearing loss fitted with hearing aid after hearing evaluation, hearing aid trial and fitting. It is conducted by providing the test signals in free field and the hearing, discrimination and comprehension of speech are evaluated.

Masking



Masking is the presentation of noise in the non test ear for the purpose of eliminating cross-hearing.

Masking is done while testing air conduction hearing as well as bone conduction hearing.

For masking broad band noise, narrow band noise, white noise etc. are used. Narrow band noise is the most effective noise for masking.

Inter aural attenuation is the effective reduction in the intensity of the test signal of the test ear when it crosses over to the opposite ear.

In air conduction hearing inter aural attenuation is 35 dB.

In bone conduction hearing inter aural attenuation is 0 dB, that is there is no reduction in the intensity of the test signal given to the test ear reaches the non test ear. This is so because when the bone conduction vibrates as a result of sound stimulation, the skull, as a whole, vibrates and the bone conducted sound is received in both ears at equal intensity.

Minimum Masking is the intensity of noise that is required to make a test signal of intensity of OdB inaudible in the non test ear. Minimum masking is 40 dB. That is, the minimum intensity of noise required to mask a signal of OdB is 40 dB of noise.

Effective masking is the minimum intensity of noise required to mask the test signal in the on test ear. Effective masking is calculated by using the formula.

Minimum masking = Intensity of test signal in test ear - inter aural attenuation + 40 dB. (An intensity of noise of 10-15 dB above the level of effective masking well not affect the threshold of the test ear.)

Over masking is the condition where the intensity of the masking noise in the non test ear effects the hearing of the test signal in the test ear. Noise levels in non test ear of intensities exceeding 15 to 20 dB above effective masking will result in over masking

Masking Noise

There are three types of noises that are used for masking, which are white noise, narrow band noise and speech noise.

White noise/Broad band noise: White noise contains all the frequencies in the audible spectrum and is comparable to the white light which contains all the colours of visible spectrum, which is used for masking.

Narrow Band Noise: It is the most effective type of noise used for masking and contains a small range of frequencies. It contains small range of frequencies above and below the frequency to be masked.

Speech noise: It is a noise having frequency range of 300 - 3000Hz only.

Biological Calibration of Audiometers

Audiometry is the measurement of hearing and audiometer is the instrument for measurement of hearing. If the measurement of hearing has to be correct and reliable the audiometer must be maintained in a state of calibration.

Audiometer calibration is of two types, which are (a) Instumental calibration by making use of calibration equipments and (b) biological calibration.

In the clinical situation the audiometer calibration is ensured by resorting to biological calibration. Biological calibration is done by comparing the thresholds of the tester daily or periodically with the thresholds obtained on the same person on the day on which the audiometer was brought to the clinic after a physical calibration. So the original thresholds of the tester is compared with the repeated thresholds and the difference between the original thresholds and the repeated thresholds are noted, and this difference is added to or subtracted from the obtained thresholds of the day. In this way the audiometer not in calibration physically is used to obtained actual reliable thresholds.

Detailing of practicals

- Performing Pure Tone Audiometry of normal cases (10) and plotting audiogram independently.
- Manifestation of threshold shift in different levels of masking in the opposite ear.
- Subjective calibration of audiometer.

TE Questions

1. A person is subjected to hearing evaluation and results obtained is as follows.

Right ear	250	500	1000	2000	4000	8000
AC	40	50	50	45	50	65
BC	15	15	15	15	……	…..

   a) Plot an audiogram using the given data.
   b) Evaluate the plotted audiogram.
   c) Mention the charecteristics of this type of deafness.
2. Is it necessary to mask opposite ear while conducting pure tone audiometry. Justify your answer.
3. Prepare a chart showing the notations used in pure tone audiometry.
4. Audiometer should be checked daily before conducting the test. Mentions the steps that you follow during daily check.

4.2. Special Tests of Hearing

Overview

The pure tone special tests of hearing was developed for the purpose of differentiating between cochlear and retrocochlear pathologies. In cases of hearing loss such as recruitment or tone decay the most common special test are, SISI, ABLB and TDT

Learning outcomes of the unit

- Defines recruitment.
- Identifies the different test to find out recruitment.
- Explains the different test procedures of recruitment.
- Practices SISI, ABLB and tone decay test.
- Analyzes the test results of SISI, ABLB, and tone decay test.

Recruitment

Recruitment is an abnormal growth in the loudness of a continuous sound without a corresponding increase in the actual intensity of sound. The ear which does not hear low intensity sounds begins to hear greater intensity sounds as loud or even louder than normal hearing ear. Thus a loud sound which is tolerable in normal ear may grow intolerably loud in recruiting ear. The patients with recruitement are poor candidates for hearing aids. Recruitement is typically seen in lesions of cochlea (Eg: meniere's disease, presbycusis) and thus helps to differentiate a cochlear from a retrocochlear sensoryneural hearing loss. Recruitment is related to dysfunction of the cochlea with an alteration in endolymph as well as structural change in the organ of corti.

Test for Recruitment

a. SISI Test (Short Increment Sensitivity Index Test)

Patients with cochlear lesions distinguish smaller changes in intensity of pure tones better than normal persons and those with conductive or retrocochlear pathology. SISI test is thus used to differentiate a cochlear from a retrocochlear lesion.

In this test, a continuous tone is presented 20dB above the threshold and sustained for about 2 minutes. Every 5 seconds the tone is increased by 1dB and 20 such beeps are presented. Patient needs to indicate the beeps heard. Percentage of beeps heard is calculated.

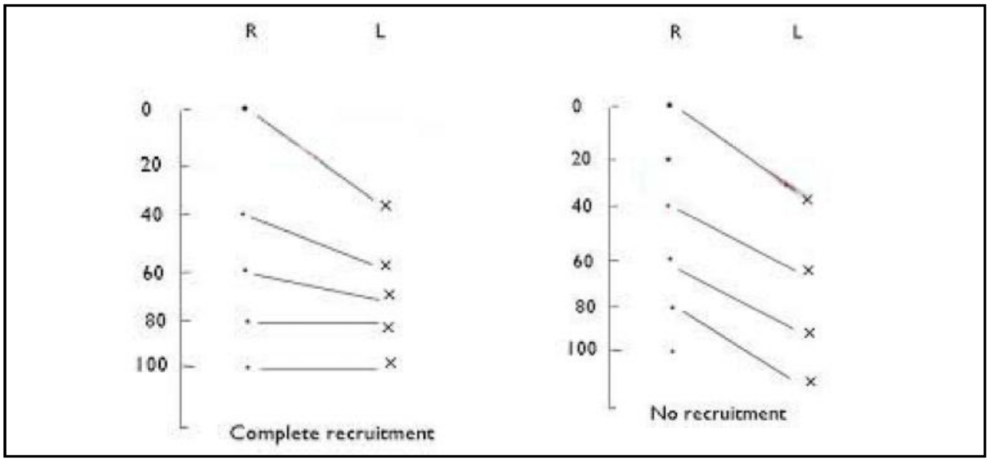
Patients with normal hearing, conductive deafness, and retro cochlear disorders (beyond cochlear) obtained very low SISI score, usually between 0-20% (-ve SISI). Patients with cochlear disorders usually have high scores of 70 - 100% (+ve SISI)

b. ABLB Test (Alternate Binaural Loudness Balance Test)

This test is used clinically to determine whether recruitment is present in the abnormal ear of patient with unilateral deafness. This test compares loudness growth in the abnormal ear with the loudness growth in the normal ear.

A tone above the air conduction threshold is introduced in the good ear and held for 1second. A tone of the same frequency and intensity is then introduced into the opposite ear (deaf ear).

The tone is presented to each ear alternately and the intensity in the deaf ear is raised or lowered until the patient indicates that the tone in each ear is equally loud.



The starting intensity is threshold + 20dB. This balancing test continues at 20 dB intervals in good ear until full recruitment is reached or the test is discontinued when the patient experiences discomfort. The frequencies usually tested at 500 Hz, 2K Hz, 4KHz. The results of ABLB test is recorded in a laddergram. For plotting ladder gram 'O' is used to indicate hearing level at right ear and 'X' for left ear. The two symbols are joined by a line to show that both ear are equally loud.

Laddergram showing nonrecruiting and recruiting cases.

Test for Auditory Adaptation

Tone Decay Test (TDT)

It is a measure of nerve fatigue and is used to detect retro cochlear lesions. Normally a person can hear tone continuously for 60seconds. In nerve fatigue, he stops hearing earlier.

A tone of 4000Hz is presented at 5dB above the patient's threshold of hearing, continuosly for a period of 60seconds. If the patient stops hearing earlier, intensity is increased by another 5dB. The procedure is continued till the patient can hear the tone continuously for 60seconds or no level exists above the threshold where the tone is audible for full 60seconds.the result is expressed as number of decay. A decay more than 25dB is diagnostic of a retrocochlear lesion.

Assessment activity

1. Which are the increments used in SISI test?
2. Which intensity increment is used for evaluation in the SISI test?
3. In which order one dB increments are presented for SISI test?
4. Draw ladder gram for the ABLB Test conducted.

Detailing of practicals

Short increment sensitivity index

Aim:

To test the ability of the case to detect increments of 1 dB in a continuous tone presented to the case of 20 dBSL.

Instruction:

The case is instructed to listen to the continuous tone and report when they experience an increase in the loudness of the continuous tone reaching the ear by raising and putting down the index finger. Responses are expected for every loud, soft or feeble increase in loudness.

The case is made familiar with the test by eliciting responses for 5dB and 3dB increments for a number of times. Then the increment intensity is set at 1dB and 5 one dB increments are presented and the responses noted. After this the increments intensity is shifted to 0dB. If no false responses is obtained at 0dB increment, the increment intensity is shifted to 5dB followed by 3dB and then 5 one dB increments. Thus by ensuring false positive responses 20 one dB increment responses are noted. The total number of reliable responses multiplied by 5 gives the SISI score.

SISI score in the range of	0-20% is negative
	25-65% doubtful
	70-100% Positive

ABLB (Alternate Binaural Loudness Balance) TEST

Aim:

To detect the presence of recruitment.

Recruitment is generally present in cochlear losspatients. Here it is presumed one ear is normal or near normal.

Purpose: Used in evaluation of sensor neural hearing loss.

Procedure

Initial settings

Audiometer Function Selector is shifted to ABLB

The headphones are put on

Test frequencies: 250-4000Hz

Instructions to the patient

You are going to hear a tone first in your normal ear and then in the poorer ear.

The tone will be coming alternatively to both ears. The Loudness of tone in your normal ear will be constant but the loudness in your poorer ear will vary. You have to indicate to me (by raising or lowering your hands) whether the loudness in the poorer ear is less/equal/more than the loudness in the normal ear. The test will continue till you say that the loudness in both the ears is the same. You should judge the loudness as correctly as possible.

Method:

The tone in the better ear is set at 20dBSL and the tone is presented continuously. Now the same tone is also available in the poorer ear. Now the case is asked to match the tones for equal loudness by raising or lowering the intensity of the tone in the poorer ear. The two intensities are recorded on the laddergram of the respective frequencies. The same is repeated for intensities 40dBSL, 60dBSL, 80dBSL etc up to audiometric limits for normal ear and the respective intensities for the affected ear are established and noted in the laddergram.

Interpretation:

Convergence of the spokes in the laddergram towards the affected side indicates recruitment.

Tone decay test

To detect the retro cochlear lesions.

Principle:

This test determines if the hearing threshold deteriorates with continuous tone stimulation close to threshold.

Procedure:

1. Instructions to patient: He will be listening to a continuous tone and he must indicate that he hears the tone by raising his finger. He must keep his finger raised as long as he is able to hear the tone. He must put his finger down immediately when he ceases to hear the tone and raised again, When he starts hearing the tone again.
2. The test is started at 20 dB above threshold and the stop watch started. The tone is raised in steps of 5dB every time the case stops hearing and it is maintained continuously for period of 1 minute or the total increase reaches 35dB SL (35db + threshold intensity). The tone decay is conducted on frequencies 4k,2k,1k and 500Hz in that order.

Interpretation:

If the noted tone decay is

0 - 5dB in 60 seconds tone decay is normal.

10 - 15 dB in 60 second tone decay is mild.

20 - 25 dB in 60 seconds tone decay is moderate.

35 dB or more in 60 seconds tone decay is marked.

TE Questions

1. A Person with recruitment is a poor candidate for hearing aid. Justify this statement.
2. Draw laddergrams showing recruiting and non recruiting cases.
3. SISI score of two persons are 15 and 95. Identify the case with recruitment. State the reason.
4. What is the specific observation in tone decay that is not normal.

4.3. Speech Audiometry

Overview

Speech audiometry has become a fundamental tool in hearing-loss assessment. In conjunction with pure-tone audiometry, it can aid in determining the degree and type of hearing loss. Speech audiometry also provides information regarding discomfort or tolerance to speech stimuli and information on word recognition abilities.

The information gained by speech audiometry helps to determine proper gain and maximum output of hearing aids and other amplifying devices for patients with significant hearing losses and help assess how well they hear in noise. Speech audiometry also facilitates audiological rehabilitation management.

Learning outcomes of the unit

Speech Audiometry

- Identifies the importance of speech audiometric test.
- Chooses the right test environment.
- Recognizes the various parameters associated with speech audiometry.
- Identifies the significance of SRT test.
- Explains the procedure of SRT test.
- Analyzes the SRT of each ear.
- Identifies the significance of SD test.
- Explains the procedure of speech discrimination test.
- Records SD score of each ear.
- Analyzes the SD score.
- Defines MCL,UCL & DR.
- Explains the significance of MCL, UCL, DR.
- Records MCL, UCL.
- Analyzes DR.

Indications

Speech audiometry can be used for the following:

- Assessment of degree and type of hearing loss.
- Examination of word recognition abilities.
- Examination of discomfort or tolerance to speech stimuli.
- Determination of proper gain and maximum output of amplifying devices.

Equipment

In most circumstances, speech audiometry is performed in a 2-room testing suite. Audiologists work from the audiometric equipment room, while patients undergo testing in the evaluation room. The audiometric equipment room contains the speech audiometer, which is usually part of a diagnostic audiometer. The speech-testing portion of the diagnostic audiometer usually consists of 2 channels that provide various inputs and outputs.

Speech audiometer input devices include microphones (for live voice testing), tape recorders, and CDs for recorded testing. Various output devices, including earphones, ear inserts, bone-conduction vibrators, and loudspeakers, are located in the testing suite.

Tests using speech materials can be performed using earphones, with test material presented into 1 or both earphones. Testing can also be performed via a bone-conduction vibrator. In addition to these methods, speech material can be presented using loudspeakers in the sound-field environment.

Parameters of speech audiometry

The main parameters of speech audiometry are:

1. Speech awareness/detection threshold
2. Speech reception/recoginition threshold (SRT)
3. Speech discrimination score (SDS)

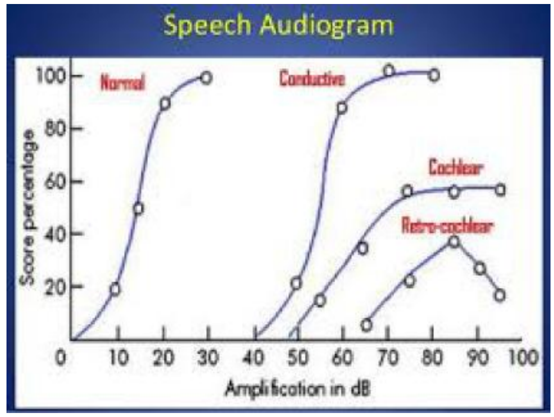
1. Speech-awareness thresholds

Speech-awareness threshold (SAT) is also known as speech-detection threshold (SDT). The objective of this measurement is to obtain the lowest level at which speech can be detected at least half the time. This test does not have patients repeat words; it requires patients to merely indicate when speech stimuli are present.

The SAT is especially useful for patients too young to understand or repeat words. It may be the only behavioral measurement that can be made with this population. The SAT may also be used for patients who speak another language or who have impaired language function because of neurological insul.

2. Speech-recognition threshold

The speech-recognition threshold (SRT) is sometimes referred to as the speech-reception threshold. The objective of this measure is to obtain the lowest level at which 50% of the words are repeated correctly by the patient.



A set of spondee words (two syllable words with equal stress on each syllable, Eg: baseball, sunlight, daydream etc) is delivered to each ear through the headphone of an audiometer. The wordlists are delivered in the form of recorded tapes or monitored voice and their intensity varied in 5dB steps until half of the words given are repeated correctly.

In clinical practice, there is a correlation between SRT and PTA of a person.

SRT=PTA+/-12dB

SRT better than PTA by more than 10dB suggests a functional hearing loss i.e. malingering.

3. Speech discrimination score (SDS)

It is a measure of patient's ability to understand speech. Here phonetically balanced (PB) words (single syllable words e.g. pin, sin, day, bus etc.) are delivered to each ear at an intensity 30-40 dB above the SRT. SDS is the percentage of words correctly heard by the patient. In normal persons or those with conductive hearing loss a score of 90-100% can be obtained. In sensory hearing loss a) SDS is reduced in cochlear hearing loss b) Very much reduced in retro cochlear hearing loss.

Thus speech audiometry helps

1. To differentiate an organic hearing loss from the functional one.
2. Indicates the intensity at whioch discrimination score is the best, which is useful for fitting hearing aid.
3. Helps to differentiate a cochlear from retrocochlear lesion.

Most comfortable loudness level and uncomfortable loudness level

Most comfortable loudness level

The test that determines the intensity level of speech that is most comfortably loud is called the most comfortable loudness level (MCL) test.

- For most patients with normal hearing, speech is most comfortable at 40-50 dB above the SRT.
- MCL is reduced for many patients who have sensorineural hearing loss (SNHL).

- MCL measurement can be obtained using cold running or continuous speech via recorded or monitored live-voice presentation. Patients are instructed to indicate when speech is perceived to be at the MCL.
- MCL can be used to help determine hearing aid gain for patients who are candidates for amplification.

Uncomfortable Loudness Level (UCL)

It is the minimum intensity level at which the speech is uncomfortably loud for the person. For normal hearing subjects this intensity often extends to the upper limit of the intensity level of the audiometer (100 - 120 dB). The patient is instructed to give signal when the speech is uncomfortably loud.

- Helps to determine the upper hearing limit for speech.
- It provides the maximum level at which word-recognition tests can be administered.
- UCL can also indicate maximum tolerable amplification.
- UCL is also called threshold of discomfort, tolerance level, and the loudness discomfort level (LDL).

Dynamic Range (DR)

Dynamic range represents the limits of useful hearing in each ear and is computed by subtracting SRT from UCL. For many patients with SNHL, this range can be extremely limited because of recruitment or abnormal loudness perception.

Detailing of practicals

Speech audiometry

a. Test of speech Reception Threshold (SRT)

b. Test of speech discrimination (SD)

Aim:

The purpose of conducting the SRT test is to establish whether the results of pure tone audiometry test conducted are reliable or not.

The purpose of conducting speech discrimination test is to find out whether discrimination loss is available or not.

These tests are useful in differentiating hearing losses due to conductive, cochlear, or retrocochlear pathology.

SRT

The test material used for conducting SRT test is a list of 20 spondiac words. Each spondiac word contains two monosyllabic words spoken with equal stress.

Testy administration

To begin with the case is instructed to listen to and repeat the spondaic words that are heard through the headphones. Spondiac words are presented at 20 dB above the PTA of the ear tested. The words are presented in succession, each time the intensity of the test spondaic words is reduced insteps of 5 dB till the intensity required to make the case repeat 50% of the spondaic words is obtained. SRT is the minimum intensity required to make the case repeat correctly 50% of the spondaic words. If the pure tone audiometry test results are reliable, the obtained SRT will be very much nearer to PTA of the case of that ear.

SD

SD test is conducted making use of phonetically balanced word list. Phonetically balanced word list contains 25 words each. The PB word list are presented at an intensity of 40 dB above SRT of that ear of the case. The SD scores are equal to the number of PB words repeated correctly by the case multiplied by 4. Higher discrimination scores suggest better speech discrimination.

Uncomfortable loundness (UCL)

Aim:

To establish level at which the listener reports sound as being uncomfortable.

Principle:

This test determines the sound levels at which pure tones are perceived as uncomfortably loud. The difference b/w uncomfortable loudness level and hearing threshold level is a measure of dynamic range of hearing.

Instruction to the patients

1. You are going to listen to sounds which will be made louder and louder.
2. You have to indicate when the sound become uncomfortably loud.
   (i.e. you would not be able to listen the tone for any length of time).

Procedure:

1. Starting at a level (in dB) is comfortable for the patient on the grounds of the pure tone audiogram.

2. 1 second tone pulses are presented monaurally at 1 second intervals for chosen frequency.
3. Intensity is increased in 5 db steps.
4. The patient is told to indicate as soon as the sound becomes uncomfortably loud

Interpretation:

Normal hearing subjects usually refer discomfort around 90dB.

Most comfortable loudness level

Aim:

To establish the level at which a patient can tolerate loud sounds within comfortable limits.

Principle:

It is the intensity at which speech is most comfortable for the patient. The patient is instructed to signal, when speech is most comfortably loud for him, as the examiner varies the intensity at supra threshold levels.

Procedure:

1. Starting at threshold for the test frequency the patient is presented monaurally with 1 second tone pulse at 1 second intervals.
2. Stimulus intensity is increased in 5 dB steps and the patient is told to indicate when the sounds become too loud.
3. Intensity is then decreased by 10 dB.
4. Steps 2 and 3 are repeated in order to allow the patient to adjust to the various levels, until a level is reached which the patient estimates as being most comfortable.

Interpretation:

1. Most normal hearing subjects cantolerate sounds at about 50-70d B.
2. Subjects with tolerance problems will report on MCL which can be as low as 15-20dB.

Assessment activity

Find out the dynamic range of any three persons and compare the results.

TE Questions

1. List the indications of speech audiometry?
2. SDS of Mr.X is 30%. Interpet the result with justification.
3. What isPTA-SRT correlation?
4. Compare SRT and SD.

4.4. Objective tests of hearing

Overview

Objectivetests of hearing require no voluntary indication from the patient that an auditory stimulus has been perceived. It is possible, however, for the patient to influence the results by interfering with the procedure. Objective tests are not a measure of hearing as such; they assess the integrity at various levels of the auditory pathway but not its entirety. It also helps us to test difficult to test population i.e. children, disabled persons, malingerers etc.

Objective hearing tests include:

- Auditory brainstem response testing - to check the electrical activity in the brain in response to a sound. Electrodes are placed on the head to measure the brain waves.
- Otoacoustic emission testing - to check the function of the tiny haircells in the cochlea. The faint sound made by the haircells in response to sound is called the otoacoustic emission.
- Tympanometry - A rubber tip is inserted into the ear and air is pumped into the ear canal. This is not a test of hearing, but checks if the eardrum can move normally.

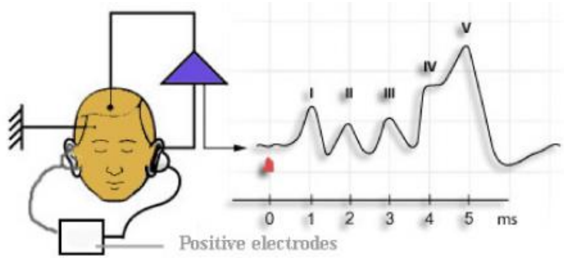
This chapter is devoted to a brief description of objective measurements widely used in audiology - immittance audiometry, evoked otoacoustic emission and the auditory brainstem response (ABR).

Learning outcome of the units

- Explains objective audiometry.
- Identifies the significance of objective audiometry.
- Defines BSERA.
- Identifies the significance of BSERA.
- Explains the procedure in brief and BSERA graph familiarization.
- Defines OAE.
- Identifies significance of OAE.
- Explains procedure in brief and familiarization of test results.
- Defines the principle of Tympanometry.
- Identifies the parts and functions of tympanometer.
- Explains the procedure of Tympanometry.

- Compares different tympanograms i.e. middle ear compliance/impedance, middle air pressure and AMR threshold.

Brain stem evoked response audiometry BSERA/BERA



BERA is an objective way of eliciting brain stem potentials in response to audiological click stimuli. These waves are recorded by electrodes placed over the scalp. This investigation was first described by Jewett and Williston in 1971.

Even though BERA provides information regarding auditory function and sensitivity, it is not a substitute for other methods of audiological evaluation. It should be viewed in conjunction with other audiological investigations.

Procedure:

The stimulus, either in the form of click or tone pip is transmitted to the ear via a transducer placed in the insert ear phone or head phone. The wave forms of impulses generated at the level of brain stem are recorded by the placement of electrodes over the scalp.

Electrode placement:

Since the electrodes should be placed over the head, the hair must be free of oil. The patient should be instructed to have shampoo bath before coming for investigation. The standard electrode configuration for BERA involves placing a non inverting electrode over the vertex of the head, and inverting electrodes placed over the ear lobe or mastoid prominence. One more earthing electrode is placed over the forehead. This earthing electrode is important for proper functioning of preamplifier.

Since the potentials recorded are in far field, well displaced from the site of impulse generation, the wave forms recorded are very weak and they need to be amplified. This amplification is achieved by improving the signal : noise ratio.

In auditory brain stem evoked response audiometry, the impulses are generated by the brain stem. These impulses, when recorded, contain a series of peaks and troughs. The positive peaks (vortex positive) are referred to by the Roman numerals I - VII.

These peaks are considered to originate from the following anatomical sites:

1. Cochlear nerves - waves I and II
2. Cochlear nucleus - wave III
3. Superior olivary complex - wave IV
4. Nulclei of lateral lemniscus - wave V
5. Inferior colliculus - waves VI and VII

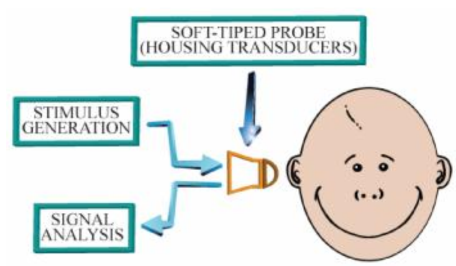
These peaks occur in most readable form in response to click stimuli over a period of 1 - 10 milliseconds after the stimulus in normal hearing adults.

BERA is resistant to the effects of sleep, sedation and anesthesia.

Uses of BERA

- It is an effective screening test for evaluating the cases of deafness due to retro cochlear pathology.
- Used in screening new borns for deafness.
- Used for intra - operative monitoring of central and peripheral nervous system.
- Monitoring patient in ICO.

OtoAcoustic Emission (OAE)



OtoAcoustic Emissions are low intensity sounds produced by movements of outer hair cells of cochlea and are produced either spontaneously or in response to the acoustic stimuli. The normal cochlea does not just receive sounds. It also produce low intensity sound called O to Acoustic Emission. These sounds are produced by the cochlea, most preferably by the cochlear outer haircells, when they expand and contract. This is a relatively new test used to asses hearing process in newborns.

Absence of Oto Acoustic Emissions indicates structurally damaged or non functional outer hair cells.

In this test a probe that contains both a loudspeaker and a sensitive microphone is inserted into the ear.

Principle: Tones are sent from the loudspeaker it travels through the middle ear and stimulates the hair cells in the cochlea. The hairs respond by generating their own minute sound which are detected by the microphone and is called oto acoustic emission.

If there is a hearing loss the hairs in the cochlea does not generate this minute sound.

There are 4 types of OAE.

1. *Spontaneous Oto Acoustic Emission (SOAE):* These are sounds emitted from the cochlea without an acoustic stimulus.
2. *Transient evoked oto acoustic emission (TEOAE):* There are sounds emitted in response to an acoustic stimulus of very short duration usually click.
3. *Distoration product Oto Acoustic Emission (DPOAE):* These are sounds emitted in response to two simultaneous tones of different frequencies.
4. *Sustained frequency Oto Acoustic Emission (SFOAE):* These are sounds emitted in response to a continuous tone.

Conditions Required for OAE Test

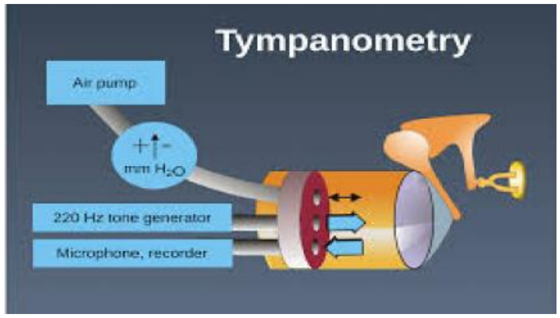
- Unobstructed EAC
- Seal of the EAC with the probe
- Optional positioning of the probe
- Absence of the Middle ear lesion
- Functioning of the cochlea outer hair cells
- Relatively quiet recording environment

Impedence audiometry

It is an objective test widely used in clinical practice and is particularly useful in children. It consists of:

a. Tympanometry
b. Acoustic reflex measurements

Tympanometry



It is based on a simple principle, i.e. when a sound strikes a tympanic membrane, some of the sound energy is absorbed while the rest is reflected. A stiffer tympanic membrane would reflect more of sound energy than a compliant one. By changing the pressures in a sealed external auditory canal and then measuring the reflected sound energy, it is possible to find the compliance or stiffness of the tympano-ossicular system and thus find the healthy or diseased status of the middle ear.

Equipment

Essentially, the equipment consists of a probe which snugly fits into the external auditory canal and has three channels:

i. To deliver a tone of 220Hz- probe tone
ii. To pick up the reflected sound through a microphone and
iii. To bring about changes in air pressure in the ear canal from positive to normal and then to negative

Procedure

After an otoscopy (examination of the ear with an otoscope) to ensure that the path to the eardrum is clear and that there is no perforation, the test is performed by inserting the tympanometer probe in the ear canal. The instrument changes the pressure in the ear, generates a pure tone, and measures the eardrum responses to the sound at different pressures. By charting the compliance of tympano-ossicular system against various pressure changes, different types of graphs called tympanograms are obtained which are diagnostic of certain middle ear pathologies.

Types of tympanogram

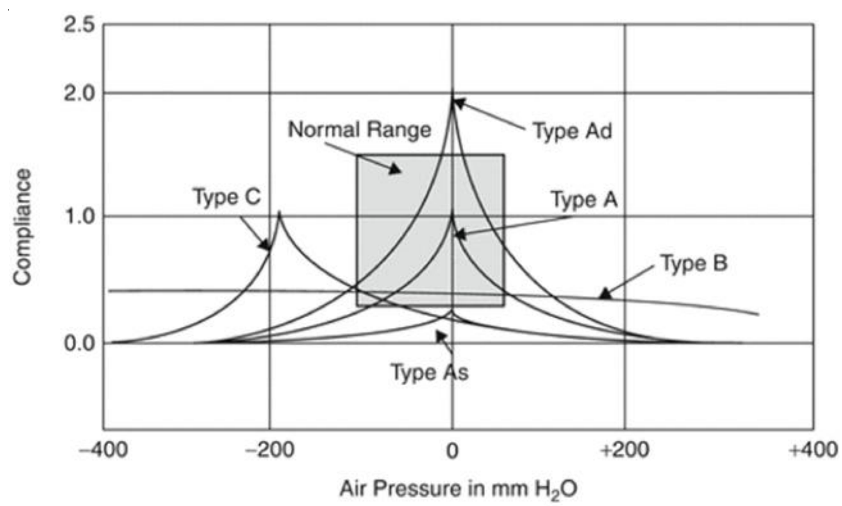
Type A — Normal Tympanogram.

Type As — Compliance is lower at or near ambient air pressure. Seen in fixation of ossicles, Eg: otosclerosis or malleus fixation.

Type Ad — High compliance at or near ambient pressure. Seen in ossicular discontinuity or thin and lax tympanic membrane.

Type B A flat or dome shaped graph. No change in compliance with pressure changes. Seen in middle earfluid or thick tympanic membrane.

Type C Maximum compliance occurs with negative pressure in excess of 100mm of H2O. Seen in retracted tympanic membrane and may show some fluid in middle ear.



Acoustic Reflex Test

The Acoustic reflex test is a measure of the threshold at which the stapedial reflex occurs. It is based on the fact that a loud sound, 70-100dB above the threshold of hearing of a particular ear causes bilateral contraction of the stapedial muscles which can be detected by tympanometry. Tone can be delivered to one ear and the reflex can be picked up from the same ear (ipsilateral) or the opposite ear (contralateral).

The instrumental setup to measure the acoustic reflex is a tymponometer having a method of delivering both a sound to either ear as well as measuring the admittance of a tympanic membrane. Reflex may be measured in 500 Hz, 1000 Hz, 2000 Hz.

The amplitude of the reflex latency (The time delay between the stimulus and the response to the stimulus) can be recorded. The reflex latencies in normal patient are 101 ms ranging from 40 - 150 ms.

Generally threshold of 70-90 dB sound is required to produce an acoustic reflex in a normal hearing person. Reflex may be absent even to louder inputs in person with conductive deafness, Otosclerosis or other middle ear disease and in severe SND.

Uses

- ART is helpful in checking the particular type of hearing losses in situations where patients reliability is questionable i.e. malingerers.
- They occasionally point to central nervous system malfunctioning. It helps to find auditory nerve and facial nerve lesion.
- To test the hearing in infants and young children. It is an objective method.
- To detect cochlear pathology, presence of stapedial reflex at lower intensities e.g. 40 to 60dB than the usual 70dB indicates recruitement and thus a cochlear type of hearing loss.

Detailing of Practical activity:

Observation of objective test during OJT and prepare a report.

TE questions

1. Eustachian tube disfunction causes negative pressure in middle ear. Mention the type of tympanogram in this case.
2. Draw a tympanogram of condition showing fluid in ME.
3. Draw different types of tympanogram and mention the ear conditions associated with each of them.

4.5. HEARING AIDS & EAR MOULDS

Overview

Hearing aids, or hearing instruments, are typically prescribed to people who have some residual hearing, and physically normal and healthy ears, and are available in a wide range of styles.

The main function of the hearing aid is to provide audibility of a wide range of sounds without making them uncomfortably loud to the hearing aid user. In order to achieve this, the hearing aid comprises as a minimum a microphone that picks up surrounding sounds, an amplifier that increases the level of sounds depending on the input level, and a receiver that delivers the amplified sound to the ear. To operate, the hearing aid needs power which gets from a battery. Most modern hearing aids are digital, which means that the analogue signal picked up by the microphone is converted to digital form.

Hearing aids are fitted with proper ear moulds, preferably custom ear moulds.

This unit deals with different types of hearing aids,characteristics of hearing aids, cochlear implants and earmoulds.

Learning outcomes of the unit

- Defines hearing aid.
- Identifies the parts and functions of hearing aid.
- Classifies, categories hearing aid.
- Evaluates the merits and demerits of AC and BC hearing aid.
- Decides the factors to be considered while selecting a hearing aid.
- Compares advantages of binaural hearing aid over monaural hearing aid.
- Care and maintenance of hearing aid.
- Defines ear mould.
- Recognizes the need of ear mould.
- Identifies the merits and demerits of different types of ear moulds.

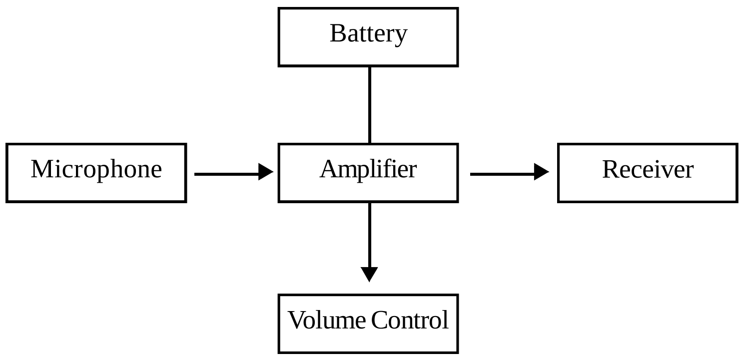
Hearing aids

A hearing aid is a device to amplify the sound reaching the ear. Essentially it consists of three parts:

- Microphone: which picks up sounds and converts them into electrical impulses.
- Amplifier: Magnifies the electrical impulses, increases the intensity of the input.
- Receiver: Converts the electrical impulses back to sound.

This amplified sound is carried through the ear mould to the ear canal.

In addition to these basic components most of the hearing aids have a gain control, tone control ON/OFF switch and battery.



Block diagram of a basic hearing aid

Characteristics of hearing aid

1) Gain
2) Maximum power output
3) Frequency response

1) Gain: Is the level of amplification across different frequencies from the hearing aid.
2) Maximum power output: It is the maximum output that can be obtained from the hearing aid. Normally the maximum power output of the hearing aid is equal to input intensity plus gain, subject to a maximum of its maximum power output (MPO).
3) Frequency response: Frequency response of a hearing aid is the range of frequencies that are available in the output of a hearing aid with their respective maximum power output across different frequencies.

Classification of hearing aids

Based on the placement hearing aids are classified in to:

1. Air conduction hearing aid: In this the amplified sound is transmitted via the ear canal to the tympanic membrane.
2. Bone conduction hearing aid: Instead of a receiver it has a bone vibrator which fits on the mastoid bone and directly stimulate the cochlea. This type of aid is specially useful in persons with actively draining ears, external otitis or with congenital absence of ear canal.

Air conduction hearing aids are the following types.

A. Body worn hearing aids

This is the out fashioned model of hearing aids, which is kept in the pocket of the user. In body worn hearing aid, the microphone, amplifier and batteries are housed within the hearing aid case. A hearing aid cord links the receiver of the hearing aid with the case. The receiver is attached to a solid ear mould and fits to the ear. These hearing aids are extremely useful in profound hearing loss cases, as it can provide sufficient gain without feedback. They ordinarily have as much high frequency range.

Merits

1. Able to manipulate the control switch easily
2. No feedback problem
3. Low cost
4. More battery life

Demerits

1. Less clarity of sound (high wind/cloth noise)
2. Cosmetic appearance is less
3. Localisation problems present

B. Behind the ear (BTE) hearing aids

These are conventional hearing aids designed to fit behind the pinna. They fit to a range of mild to profound hearing losses. This is the most commonly used hearing aid. These are available in a variety of sizes. Many of these can be connected to an external sound source such as assistive listening devices via connecting cord audio boot.

Merits

1. Fits to a wide range of hearing loss
2. Can be easily serviced
3. Various control operations are available
4. Better battery life
5. Better localization

Demerits

Cosmetic problem

C. In the ear (ITE) hearing aids

In ITE hearing aids the components are housed in a shell that fits the outer part of the ear(concha).

Merits

1. Less feedback problem compared to CIS.
2. Venting possible (putting small hole through the hearing aid tocut unwanted frequencies).

Demerits

1. Low battery life
2. Not suitable for profound hearing loss

D. In the canal (ITC) hearing aids

The size of the ITC is b/w ITE &CIC hearing aids. The aid fits within the conches & cartilaginous portion of the ear canal.

Merits

1. Good cosmetic appearance
2. Telephone use more comfortable

Demerits

1. Less battery life
2. Not suitable for extreme hearing loss ears

E. Completely in the canal (CIC) hearing aids

These are the smallest hearing aids. Their components are housed entirely within the cartilaginous portion of the external auditory canal.

Merits

1. Improved cosmetic appearance
2. Less feedback problem
3. Normal telephone use

Demerits

1. Need to have large ear canal
2. Not suitable for extreme hearing loss
3. Less battery life and high cost

F. Spectacle type hearing aids

In this all the components of the hearing aid are housed within the auricular part of the spectacle frame. They are suitable for a wide range of hearing loss. The main disadvantage is the need to combine optics with hearing aid.

Based on technology hearing aids can be classified into: Analog, programmable &digital hearing aids.

A. Analog - Analog hearing aid uses conventional electronics, which is now becoming outdated. It amplifies the continuous sound waves by simply making it larger. It cannot differentiate different sounds and so they amplify all the sounds equally. This results in some sound to be too loud while others may be difficult to hear. This can be adjusted by changing the volume of the hearing aid. It provides less speech clarity compared to digital aids

B. Programmable hearing aid - It is an advanced type of hearing aid. They are equipped with different programs that are saved in it. These programs can be switched on /off depending upon the environment. They are less costly compared to digital hearing aids.

C. Digital hearing aids - These instruments take the incoming signal from the microphone and converts it into a digital format and then processes the signal using digital technology before converting to analog sound. The signal are processed with high speed processor according to instructions written to the chip. It eliminates the need for most conventional analog components. In fact digital hearing aids are wearable mini computers.

Hearing aid selection

While selecting a hearing aid, consideration is given to:

1. Type of hearing aid
2. Which ear should be fitted
3. Configuration of hearing loss (type of frequency affected)
4. Degree of hearing loss
5. Type of hearing loss

6. Age and disability of the patient
7. Speech discrimination score
8. Threshold of discomfort
9. Comfortable loudness level
10. The hearing aid should have maximum acoustic output, gain & frequency response.
11. Presence of recruitment
12. Condition of the outer and middle ear
13. Cosmetic acceptance of the aid
14. Type of ear mould
15. Type of fitting (Monoaural or Binaural)

Monaural vs Binaural Hearing Aid

Monaural hearing aid: If one ear is fitted with hearing aid it is called monaural hearing aid.

Binaural hearing aid: Consists of 2 complete hearing aids so that each ear is provided with its own separate microphone amplifier and reciever.

Advantages of binaoural hearing aid:

- Improved sound localisation
- Improved sense of distance from the sound source
- Improved speech discrimination in noise
- Binaural frequency advantage
- Improved quality
- Avoidance of head shadow effects
- Subjective feeling and balanced hearing

Care and maintenance of hearing aid

Hearing aids are small, expensive electronic devices that require special care to ensure proper functioning.

- Visual check

Check the hearing aid daily to find any cracks in casing, ear hook etc. Check for presence of wax in tubing, check any battery leak.

- Listening check

Listen through hearing aid using a listening tube and ensure that the sound comes clear and not weak. Listen for any turbulence or breaking of output. Listen to find any whistling sound.

- Check batteries

Use a battery tester to check the strength of batteries. Batteries should be removed if the hearing aid is not in use for a long period of time.

- Clean hearing aid regularly

Check for dirt or grease. Cleaning of hearing aid involves wiping them periodically with a dry cloth or tissue. Wax can be removed using special wax tool.

- Avoid feedback

Feedback is the whistling sound that can be heard from the hearing aid. The feedback can be avoided by placing the hearingaid properly to the ear canal, by making use of proper fitting ear moulds.

Troubleshooting tips

(If the hearing aid is weak or dead)

- Make sure that the hearing aid is switched on.
- If there is a volume control, make sure that it is turned loud enough for you to hear.
- Check the battery-is it working? Is the battery placed with the positive (+) sign facing up?
- Check the receiver opening on any vent openings and make sure they are not blocked with wax or other debris.
- Check to see if the tubing is still connected properly and that it is not bent or twisted.
- Check to see if the microphone opening is not blocked. If it is , use brush in your tool kit to clean it.

  (If the hearing aid is distorted or intermittent...)
- Check the tubing for moisture. If moisture present, remove it with an air blower.
- Check the tubing for cracks and holes. If you see any, call your audiologist.
- Replace the battery because it may be weak or defective.
- If there are cords connecting to the hearing aid or other hearing assistive device, check for cracks and replace the cord if necessary.

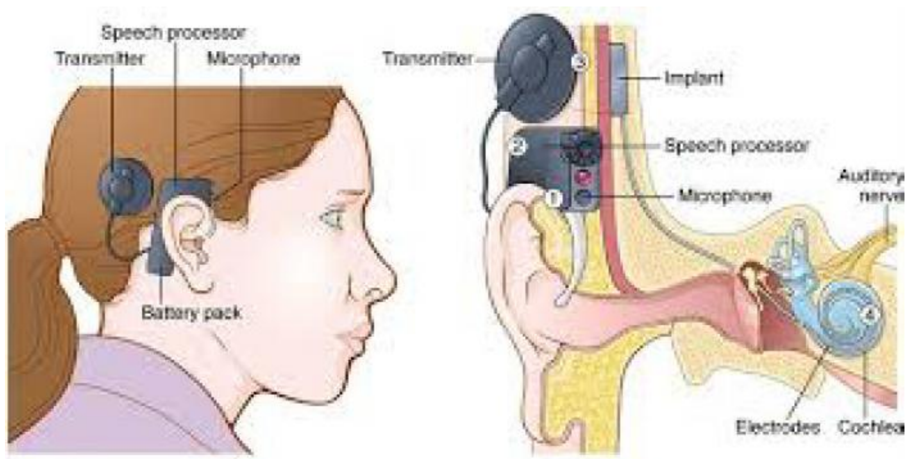
  (If the hearing aid sequels or whistles.)
- Check that the volume is not turned up too high.
- Be sure the instrument or ear mould is seated snuggly in the ear.
- Make sure that the microphone is not covered by objects such as a hat, scarf, or collar.

- Have your audiologists or doctor look in your ear canal and check for excessive ear wax buildup.

Battery basics

- Remove the tab on the battery before inserting into the hearing aid.
- Insert the battery placed with the positive (+) sign facing up.
- Open the battery door when the hearing aid is not in use. Doing so will extend the life of the battery and allow the hearing aid to dry out.
- Store the batteries in a cool dry place but not in refrigerator.
- Batteries are harmful if swallowed.

Cochlear implants



Cochlear implant is an electronic device that replace the function of the damaged inner ear Unlike hearing aids, which make the sound louder, cochlear implant bypass the damaged hair cells of inner ear (cochlea) to provide sound signals directly to the brain.

The main parts of cochlear implants are:

1. A sound processor worn behind the ear or on the body, captures sound and turn it in to digital code. The sound processor has a battery that powers the entire system.
2. The sound processor transmits the digitally coded sound through the coil on the outside of head to the implant.
3. The cochlear implant converts the digitally coded sound in to electrical impulses and sends these impulses along the electrode array placed in the cochlea.

4. The implants electrodes stimulate the cochlear nerve which the sends the impulses to the brain where they are interpreted as sound.

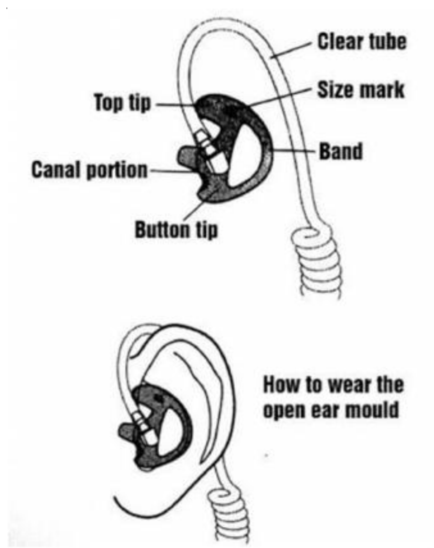
Benefits of cochlear implant

Hear better with a cochlear implant than with a hearing aid.

- Cochlear implant achieve an average of 80 % sentence understanding, compared with 10% sentence understanding for hearing aids.
- Can focus better when in noisy environments.
- Reconnect with missed sounds that they could not hear before their cochlear implant.
- Better hearing in noisy situations such as restaurants, conferences and other crowded places.

EAR MOULDS

Ear moulds are coupling devices that holds hearing aid receivers securely and comfortably to the ears of the hearing aid user.



Different types of ear moulds

Ear moulds are available in various types. The main types of ear moulds are:

1. Standard ear moulds
2. Custom ear moulds
3. Mushroom type ear tips

Ear moulds are processed in hard or soft materials.

Standard ear moulds

They are (a) Factory made ear moulds of different sizes available for right and left ear separately. They are made of hard plastic or soft materials.

Custom ear moulds

They are ear moulds made on the exact ear impression of the hearing aid user. They are made of hard or soft materials. Custom ear moulds are available in different types.

(a) Custom ear moulds with snap rings for use with pocket model hearing aids.

(b) Custom ear moulds soft or hard with attached flexible polythene tubings for use with behind the ear or spectacle air conduction hearing aids.

(c) Phantom ear moulds - with only the edges of the ear mould structure and ear canal. It is used with behind the ear hearing aids.

(d) Shell type custom ear moulds - which are good to accommodate concha type, in the canal type or completely in the canal hearing aids with in it.

Mush room type ear tips

They are made of soft materials. It has a bulbous portion which holds it tightly to the ear canal and the tubing or snap ring holds it securely to the hearing aid.

1 Processing of custom ear mould

For the making of custom ear moulds the procedures involved are:

1. Ear examinations
2. Plugging of ear canal/s
3. Ear impression
4. Trimming and waxing of ear impression
5. Preparation of Plaster caste dye
6. Processing the ear mould
7. Trimming, canalling, polishing & fixing ear mould ring or tubing

1. Ear Examination

Ear examination is conducted to make sure that the ear is free of ear infections or blockage. Ear examination is carried out using an otoscope under proper lighting.

2. Plugging the Ear canal

While attempting ear impression it is necessary to block the ear canal with threaded cotton ear Plug of the required diameter. This threaded cotton ear Plug ensures that the impression material is filled in the required space only & it is pulled out easily when it is set.

3. Ear impression

The impression material if filled in a Syringe and it is injected in to the ear to cover the canal and pinnae portion of the ear. Silicon based ear impression paste is used for ear impression.

4. Trimming and waxing of impression

The ear impression is trimmed to the exact requirements and then the impression is given a Paraffin wax coating by dipping it in molten paraffin wax.

5. Preparation of Plaster caste dye

The impression material is placed on a flat surface with its canal portion pointing upwards. The impression is covered by an ear mould flask and a plaster of paris solution in water is poured in to the ear mould flask to fill it completely. When the Plaster is set the impression is pulled out from the plaster caste and a plaster caste dye is ready.

6. Processing the ear mould

The Plaster caste dye is filled with silicon gel for soft ear mould or hydroxyl Propile methacrilite for hard ear mould. When it is Set the mould is removed from the Plaster caste.

7. Trimming, canalling, polishing & fixing ear mould or tubing

The ear mould then is trimmed, polished and fitted with Snap ring or Polythene tubing. When in the ear hearing aids are to be fitted, the ear mould is processed in hard material and the inside of the ear mould is hollowed out to accommodate the miniature hearing aid inside it.

Detailing of practicals

1. Identification of different types of hearing aids.
2. Identification of different types of ear moulds.
3. Observation of ear mould preparation during Field visit/OJT.

TE Questions

1. Which out of the following is not a part of cochlear implant.

   a) Microphone b) Headphone c) Electrode d) Speech processor

2. Draw a block diagram of a hearing aid system and explain the functions of each block.

Extended Activities

1. Screening of hearing handicapped in normal school.
2. Participation in medical camps for handicapped conducted by medical experts.
3. Visit a hearing aid center and interact with the experts.

List of Practical activities

- Familiarisation of patient preparation for pure tone audiometry.
- Observation of puretone audiometry and participating in plotting audiogram.
- Performing puretone audiometry of normal cases and plotting audiogram (10 cases).

- Manifestation of threshold shift in different levels of masking in opposite ear.
- Subjective calibration of audiometer.
- Observation of speech audiometry (5 cases).
- Perform Special tests of hearing (Tone decay, SISI, ABLB).
- Identification of various types of hearing aids and ear moulds.

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