Ear and Earning Loss

by Audiology 23

THE EAR AND HEARING LOSS

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THE EAR AND HEARING LOSS

For primitive man, survival largely depended on the acuity of his senses. His hearing, particularly, served as his radar screen. The footfalls of friend or enemy, the movement of game, the differential vocal calls of group members, the messages transmitted via drums, were all scrutinised by this versatile warning system. Undoubtedly, those who stood the test of time were those endowed with good hearing.

Our hearing is no less vital for us than it was for those in the bygone ages. From birth onwards, important links with the environment are forged and maintained through the sense of hearing. Children learn to talk by listening to and imitating people around them. Much of our knowledge about the world, people and places is gained through our ears. We rely on our hearing to alert ourselves as well as to bring to us the pleasures of sound - both natural and man-made. Our hearing also performs a reassuring function in continuously transmitting information about the environment.

A hearing defect, therefore, can profoundly affect an individual's life. Children born with severe hearing loss are deprived totally or partially of a major channel of learning. In addition, defective speech skills and abnormal voice quality are common results. Further, linguistic skills such as reading, listening and writing may also be adversely affected. The effect of even a mild hearing loss would be much more pronounced in children than in adults.

For older persons also, the impact of hearing loss is devastating. Withdrawal from active living may follow as other skills become affected. In normal speech production, the speaker hears himself and can identify or correct any error he makes. Since this feedback is not available to the severely hearing impaired individual, deterioration of speech may follow. In addition, his judgement of distance and location of the sound may become disturbed. Hence, hearing loss imposes barriers that not only create loneliness and frustration but also endangers an individual's life.

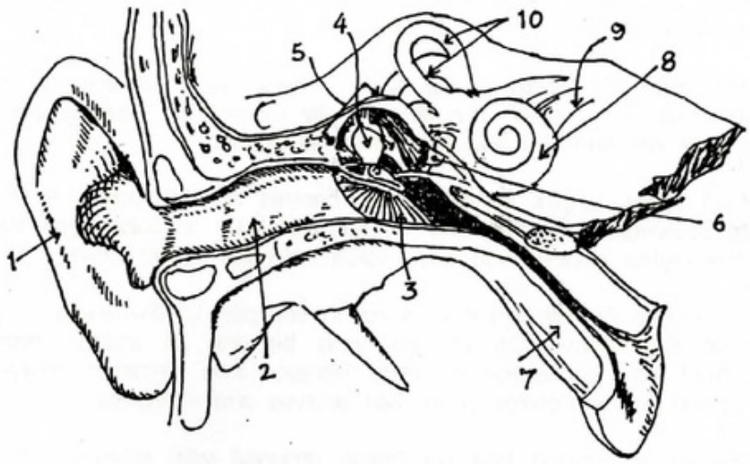
Hearing loss may set in gradually or may be acquired suddenly. In the former, at the outset, only the ability to hear soft sounds such as whispers or a watch tick may be lost. After a lapse of months/years the condition worsens. Difficulty then may be encountered in listening over the phone, in a lecture hall or in following conversation. Sudden hearing loss on the other hand, may be total and acquired within a few hours.

Hearing loss can be caused by several factors which may operate before, during or any time after birth. It could also be hereditary. Such loss could be apparent at the time of birth or may manifest itself in late childhood or in early adulthood.

A brief description of the hearing mechanism is included here to facilitate better understanding of the causes of hearing loss.

THE HEARING MECHANISM

The different parts of the auditory pathway are discussed below. The hearing mechanism can be divided into four parts viz., the external ear, middle ear, inner ear and the auditory pathway.



Structure of the Ear

1. PINNA
2. EXTERNAL EAR CANAL
3. EAR DRUM
4. MALLEUS
5. INCUS
6. STAPES
7. EUSTACHIAN TUBE
8. COCHLEA
9. AUDITORY NERVE
10. SEMI CIRCULAR CANALS

The **external** ear consists of the pinna and the external auditory canal. The pinna is a flap like structure that is visible externally. The ear canal is a curved tube leading inwards to the eardrum. The external ear aids in collecting and channelizing sound waves for onward transmission into the middle ear. It also aids in determining the direction of sound sources.

The **middle ear** is an air-filled cavity bounded by six sides. It contains a chain of three tiny bones, the ossicles, which connect the ear drum with the bony wall of the inner ear. It also contains certain muscles, ligaments and the opening of the eustachian tube. The contraction of the muscles controls the movement of the ossicular chain. The ligaments connect the ossicles with the walls of the middle ear thereby acting as supporting structures. The eustachian tube connects the middle ear with the upper portion of the throat (nasopharynx).

The middle ear is an important structure as it bridges the external and the inner ear. If the middle ear were to be absent, transmission of vibrations from the external to the inner ear would not have been efficient.

The innermost portion of the ear, The **inner ear,** houses the organ of hearing (cochlea) and the organ of balance (vestibular system). The former is composed of many specialised

cells and other supporting structures. These are surrounded by a fluid medium. The fluid is set into motion by the vibrations transmitted by the ossicles. This fluid movement in turn, activates the hair cells, resulting in generation of electrical impulses.

The impulses generated in the cochlea travel along the **auditory nerve** to the brain. Some of the nerve fibres of the auditory nerve starting from one ear, on their way to the brain, cross over to the opposite side, terminating in the opposite side of the brain. Thus some nerve fibres starting from the right ear would terminate in the left half of the brain while some others starting from the same ear would ascend to the same half of the brain. Each ear is hence represented in both hemispheres of the brain.

Enroute to the brain, the fibres of the auditory nerve form way-stations at various levels in the pathway with other nerve cells. The fibres finally reach the "hearing centre" in the brain. Impulses arriving here are analyzed and interpreted as sound.

Another set of fibres begins at the higher centres and descends to the cochlea. Thus, there is two way communication between the ear and brain. Impulses can travel upwards from the cochlea to the higher centres and downwards from the higher centres to the cochlea.

A defect in structure or function may occur in any part of the auditory system. Depending on the location of the defect, the problem may be one of sound transmission from the external to the inner ear, conversion of these vibration into electrical impulses conduction of these impulses to the higher centres or in their analysis and interpretation.

The major causes of hearing loss are herein grouped with reference to the parts of the ear they affect.

CONDITIONS ASSOCIATED WITH HEARING LOSS

THE EXTERNAL EAR :

Hearing loss in the external ear may be caused by several factors which are outlined below :

a) Congenital malformations :

i) Malformation of the pinna : This could be complete absence or an incomplete development. This condition does not cause a significant hearing loss if the other structures of the ear are intact.

ii) Closure of the ear canal : Closure can be complete or partial, in one or both ears. In such cases the hearing handicap may not be significant because the alternative mode of transmission - through the vibration of the skull bones-enables the signal to reach the inner ear. However, it is often accompanied by malformation of the middle and inner ear, in which case hearing loss may be severe, i.e., speech and other environmental sounds will not be audible to the individual.

b) Blockage of the ear canal : This could be caused by :

i) Impacted wax : Hardened wax may completely or partially seal off the ear canal, preventing sound waves from reaching the eardrum or hindering the movement of the eardrum. Hearing loss may be mild in such cases. i.e., difficulty may be encountered in

hearing soft sounds. (Refer to table for details on hearing handicaps associated with different degrees of hearing loss. See page No. 8)

ii) Foreign bodies : Foreign bodies like seeds or pebbles may cause hearing loss by blocking the ear canal or by causing injury to the eardrum. They may be inserted into the ear canal by children during play. In the case of adults, insects constitute the most commonly found foreign bodies. Hearing loss may be of mild to moderate degree.

c) Infections of the external ear :

The external ear can be infected by various organisms, the most common being the fungal infection observed among swimmers. This could give rise to mild hearing loss. It may be accompanied by symptoms such as itching and pain.

THE MIDDLE EAR

Hearing loss associated with the middle ear may arise due to :

a) Rupture or perforation of the eardrum :

The eardrum may be torn while removing wax with a sharp object like a hairpin, by foreign bodies by exposure of the ear to sudden loud sound or because of some disease conditions in the middle ear cavity. When this occurs, sound waves that strike the eardrum are not effectively transmitted to the inner ear.

b) Infections of the middle ear :

Middle ear infection is one of the most common causes of conductive hearing loss. Infections of the nose or throat such as a cold or sore throat can be transmitted through the eustachian tube to the middle ear. While blowing the nose hard, nasal secretion may be forced into the eustachian tube and thence to the middle ear where it can cause infection.

When it is infected, the middle ear gets filled with fluid. As the amount of fluid increases, pain in the ear gets worse. Finally, it tears open the eardrum. The fluid drains out through the external auditory canal and the pain is reduced. Such a spontaneous recovery may not occur if the infection persists and the condition becomes chronic.

If proper treatment is instituted in the early stages, hearing returns to normal or near normal. However, if untreated, middle ear infections can lead to several complications like meningitis, encephalitis or brain abscess. Caution should particularly be exercised when the discharge is scanty and foul-smelling.

c) Ossicular abnormalities :

For normal sound conduction, the ossicles must be properly connected not only with each other, but also with the eardrum at one end and the oval window situated on the bony cochlear wall at the other. Hearing loss results if there is :

i) Congenital absence of one or more ossicles.
ii) Accidental fracture of one of the three ossicles.
iii) Improper connection among the ossicles themselves.
iv) Fixation of one of the ossicles.
v) Fluid or any growth in the middle ear which impedes the movement of the ossicles.

vi) Otosclerosis : This is a hereditary condition affecting stapes (one of the ossicles) and the inner ear wall. The prevalence of otosclerosis among Indians is fairly high. Initially, only the conductive mechanism is affected and can be rectified surgically. However, if untreated, the disease process continues. Eventually, it may involve the inner ear too.

THE INNER EAR AND THE AUDITORY NERVE

Hearing loss can be caused by problems of the inner ear and the nerve leading from it to the brain. Any hearing loss resulting from impairment of the cochlea or auditory nerve is called sensorineural hearing loss. This type of hearing loss can be caused by :

a) Congenital malformation of the inner ear :

Maldevelopment of the inner ear can be caused by pathological conditions affecting the mother during pregnancy, such as bacterial or viral infections, drug consumption, exposure to X-rays or any injury to the mother.

Birth complications like prolonged labour, instrumental delivery, or inadequate oxygen supply, could result in damage to the inner ear or higher centres in the auditory pathway.

The probablity of occurrence of malformations of the inner ear is greater in children born in families with a history of hearing loss. In cases of hereditary hearing loss, malformations may range from a mild anomaly to complete absence of the cochlea.

b) Destruction of the hair cells of the cochlea :

The cochlear hair cells can be adversely affected by several factors, as mentioned below :

i) Aging : Advancing age is the most common cause of sensorineural deafness. This type of hearing loss is called "Presbycusis". It is attributed to physiological degenerative changes affecting the hair cells, supporting structures in the cochlea and the higher centres in the auditory pathway.

Presbycusis does not become apparent in all people at the same age. There are some old people who have good hearing and young or middle aged people who have a hearing loss due to aging.

ii) Trauma/Injury : Permanent injury to the structures within the cochlea can be incurred by exposure to a sudden blast of sound like an explosion, gunblast, etc. Profound sensorineural hearing loss can result from such an injury.

A violent blow on the external ear, too, can cause permanent damage to the inner ear. Sensorineural deafness may also be caused by fracture of the skull bone (temporal bone) housing the auditory structures. This may result from automobile and other accidents.

iii) Noise : Continuous exposure to noise like that in factories, engine rooms, etc. can gradually lead to sensorineural hearing loss. The sensation of decreased hearing sensitivity after coming out of a noisy place, such as a flour mill, is commonly experienced. After a few hours rest to the ears, hearing reverts to normal. However, this temporary hearing loss can become permanent if exposure continues over longer periods of time. How fast hearing-impairment occurs depends on the level and composition of noise present, duration of exposure and the susceptibility of the person to noise. Intake of drugs concurrent with noise exposure, has been known to increase the probability of hearing impairment.

iv) Drugs : Certain drugs like Quinine, Streptomycin, Kanamycin, etc., have proven to be harmful to the ear. They are known to destroy the hair cells and other structures within the cochlea. Since they are life-saving drugs, a total ban on their use is not possible.

v) Viral and bacterial infections : Impairment in hearing may arise subsequent to viral or bacterial infections. Viral infections like mumps, measles, and small pox are known to cause hearing loss. One example of a bacterial infection which could severely depress hearing is typhoid.

"Brain fever" (encephalitis, meningitis) following viral or bacterial infections could also damage the inner ear. These conditions could affect one or both ears causing severe hearing problems.

Additionally, infections of the inner ear following surgery or a spread of infection from the middle ear could also bring about significant hearing loss.

c) Changes in the pressure of inner ear fluids :

Hearing loss may result from alterations in the secretion, absorption and/or composition of the inner ear fluids. For instance, Meniere's disease, associated with pathological changes in the inner ear fluids, is characterised by fluctuating sensorineural hearing loss, dizziness and tinnitus. Since both the hearing and balance mechanisms are situated close together, the symptoms related to malfunctioning of the two systems may coexist.

d) Abnormalities in the blood supply to the cochlea :

Degenerative changes in the cochlea resulting in hearing loss may arise from rupture or blockage of the main blood vessels or its branches supplying the cochlea. Hearing loss arising from inadequate blood supply is usually of sudden onset. It may be accompanied by other symptoms such as dizziness. Sudden hearing loss due to vascular insufficiency is usually reversible if immediate medical attention is sought.

e) Destruction of the nerve cells of the auditory nerve :

The auditory nerve can get damaged along its pathway from the cochlea to the brain. Tumours may arise on the auditory nerve. The tumour pressing on the auditory nerve may damage it, depending on its size and location. Hearing loss, nausea and dizziness are the common complaints. The ability to discriminate between speech sounds is also severely impaired in such cases.

AUDITORY PROCESSING DISORDERS

There are people who do not have hearing loss as it is conventionally understood. Such individuals have difficulty in utilizing all the information present in the sound stimuli even though they do not seem to differ from normal hearing persons in responding to soft sounds. They may also display deficits in attention, memory and reading skills.

OTHER CAUSES OF HEARING LOSS

Non-organic hearing loss is, as the name suggests - functional or psychological and without any organic basis. The person develops a hearing loss either consciously or subconsciously as

an escape from emotional stress or responsibilities or to get certain benefits like monetary compensation.

From the foregoing, it is clear that the hearing mechanism is a delicate structure liable to damage by a number of factors. While some of these factors are beyond our control, there are many instances where appropriate and timely precautions could preserve one's hearing. Undergoing hearing tests periodically is one simple step that would aid in early detection and treatment of hearing defects. It must be remembered that hearing acuity once lost may not be regained. No effort should therefore be spared to safeguard the magnificent device which is our hearing mechanism.

TABLE

Environmental Sounds	Level in dB	Hearing Impairment	
(Approximate Values)			
Whisper at 5'	0		
	10	No Significant Hearing Impairment	
	20		
Residential area at night	30	Mild Hearing Impairment	Has difficulty hearing faint or distant speech.
	40	Moderate Hearing Impairment	
	50		Understands conversational speech at a distance of 3 to 5 feet
Conversational Speech (3')	60	Moderately severe hearing impairment	Conversation must be loud to be understood. Has great difficulty in group situations.
	70		
	80	Severe hearing impairment	May hear loud speech about one foot from ear. May identify loud environmental sounds.
Heavy Trucks (20')	90	Profound hearing impairment	May detect some very loud sounds
Crackers	100		
	110		
	120	Threshold of discomfort	
Jetliner during take off (80' from tail)	130	Threshold of pain	
	140		

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ORIGINALITY REPORT

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SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	James M. Kates. "Signal Processing for Hearing Aids", The International Series in Engineering and Computer Science, 2002 Publication	2%
2	Mary Ann Watson. "Balancing act for people with dizziness and balance disorders.", Balancing Act for People with Dizziness & Balance Disorders, 19950101 Publication	1%
3	Chasens, E. R., M. Enock, and M. DiNardo. "Reducing a Barrier to Diabetes Education: Identifying Hearing Loss in Patients With Diabetes", The Diabetes Educator, 2010. Publication	1%
4	Submitted to Southern Illinois University Student Paper	1%
5	Ranjan, Rajesh; Bhat, Jayashree and Kumar, Ajith. "Cognition and Speech Perception in Noise", Language in India, 2011. Publication	<1%
6	Chrisman, Oscar. "The Hearing of Children", The Pedagogical Seminary, 1892. Publication	<1%
7	www.theitinerantconnection.com Internet Source	<1%
8	Pajor, Anna; Danilewicz, Marian; Jankowski, Andrzej and Durko, Tomasz. "Participation of mast cells in chronic otitis media", Folia	<1%

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10	jieun.forallnations.com Internet Source	<1%
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12	Korkut, Arzu Yasemin; Teker, Aysenur Meric; Kahya, Volkan; Gedikli, Orhan and Somay, Adnan. "Middle Ear Recurrence in Nasopharyngeal Carcinoma: A Case Report", Journal of International Advanced Otology, 2011. Publication	<1%

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