

Audiometric Evaluation of Hearing Loss- A Study of 100 Cases

Asaduzzaman AKM¹, Rabbani SMG², Islam MT³, Alam S⁴, Hossain MD⁵, Azad MA⁶

Abstract

Introduction: Audiometry is the measurement of hearing acuity. If it is done by using pure tones then it is called pure tone audiometry. It is the most commonly used method for hearing measurement.

Objective: To find out the type and degree of hearing loss.

Materials and Methods: The cross sectional prospective study was carried out in the Audiology unit of the Department of Otolaryngology-Head and Neck Surgery, Combined Military Hospital (CMH), Dhaka, in a period of 06 months from 01.03.2016 to 31.08.2016 among those complaining hearing loss attending in this hospital. 100 cases of hearing impaired people were taken and the data were collected by interviewing the cases as per questionnaire from history, examinations and investigation reports.

Results: This study revealed that people of 21-30 years were most common sufferer of hearing loss and female was predominant (61%). The most common type of hearing loss was conductive type. In the right ear type of deafness were 46 cases (51.11%) of conductive type of deafness, 20 cases (23%) of mixed type of deafness and 17 cases (18.88%) of sensorineural type of deafness. In the left ear it was 53 cases (61.62%) of conductive type of deafness, 20 cases (23.25%) of mixed type of deafness and 13 cases (15.13%) of sensorineural type of deafness. This study showed that other ranks (ORs) families (45%) were commonest group of people. This study also revealed that Chronic suppurative otitis media (CSOM) (39%) was the commonest cause of hearing loss.

Conclusion: This study denoted that commonest type of hearing loss was conductive type, commonest degree of hearing loss was mild degree and commonest causes

of hearing losses were CSOM and otitis media with effusion (OME). Since, these conditions are preventable. So, appropriate measures can prevent hearing impairment in this study group.

Key-words: Audiometry, Pure tone, Deafness.

Introduction

Pure tone audiometry is an essential diagnostic tool to identify the type and degree of hearing loss as well as other aspect of hearing impairment. It is congenital or acquired; mild, moderate, severe or profound in degree; conductive, sensorineural, mixed in type and even psychological¹. The testing of hearing is most often carried out by establishing the threshold of hearing, the softest sound which can be perceived in a controlled environment². Pure tone audiometry is the most basic hearing test that records the frequency dependent sensitivity for burst of pure tones of the auditory system. This is still by far the commonest form of audiometry performed. Pure tones represent the simplest existing sound, completely characterized by one frequency value and one sound pressure level value. This simplicity provides good basis for tests with high reliability³.

The purpose of pure tone audiometry is to determine hearing threshold levels for pure tones. Hearing thresholds constitute a very basic characteristic of the auditory organ, describing its sensitivity at detecting very soft sound^{3,4}. The threshold of hearing is defined at the level of a sound at which under specified condition a person gives 50 percent of correct detection responses on repeated trials^{3,5}. The normal test sound is pure tone pulses at standardized frequencies in the range of 125–8000 Hz and normal presentation mode is monaurally by means of a standardized type of earphone. The intensity of sound can be increased or decreased in 5 dB steps from -10 dB to 120 dB^{4,6}.

1. Col AKM Asaduzzaman, MBBS, DLO, MCPS, FCPS, Classified Specialist in Otolaryngology and Head-Neck Surgery, CMH, Dhaka 2. Maj Sarder Mohammad Golam Rabbani, MBBS, FCPS, Classified Specialist in Otolaryngology and Head-Neck Surgery, CMH, Dhaka 3. Lt Col Md Tauhidul Islam, MBBS, MCPS, DLO, FCPS, Classified Specialist in Otolaryngology and Head-Neck Surgery, CMH, Dhaka 4. Lt Col Mohammad Delwar Hossain, MBBS, MCPS, DLO, FCPS, Classified Specialist in Otolaryngology and Head-Neck Surgery, CMH, Dhaka 5. Lt Col Shafiu Alam (Retd), MBBS, MCPS, DLO, Professor and Head, Dept of ENT and Head-Neck Surgery, Shahabuddin Medical College, Dhaka 6. Lt Col Muhammad Ali Azad, MBBS, MCPS, DLO, FCPS, Classified Specialist in Otolaryngology and Head-Neck Surgery, CMH, Dhaka.

Calibration is adjusted so that at each frequency 0 dB is the average threshold of a normal hearing, healthy ears. For normal manual procedures, as well as computer-control versions, the optimum step size is 5 dB. Larger step size reduces the accuracy of the measurement while smaller step size does not increase it because of limited resolution of the human auditory system close to threshold^{6,10,11}.

Pure tone audiometry has become the standard method for quantitative description of degree of hearing loss. It provides certain information regarding localization of the lesion that cause the hearing loss^{7,8,9}. The amount of intensity that has to be raised above the normal level is a measure of the degree of hearing impairment at that frequency. It is charted in the form a graph called audiogram. The threshold of bone conduction is a measure of cochlear function. The difference in the threshold of air and bone conduction (A-B gap) is a measure of the degree of conductive deafness. We found a lot of people have different type and Degree of hearing impairment. It is one of the important causes that makes a person different from of handicap and detached him from the society¹². So pure tone audiometry is a measure of threshold of hearing by air and bone conduction and this the degree and type of hearing loss, a record can be kept for future reference, pure tone audiometry is essential for treatment plan and prescription of hearing aids; helps to find out handicap for neurological purposes and helps to predict speech reception threshold¹²⁻¹⁴.

Even a hearing impaired person become burden of society. Hearing impairment is such an important issue that a deaf child cannot talk. It is typical to do this testing with pure tones by providing calibrated tones to ap person via earphones, allowing that person to increase the level until it can just be heard. Various strategies are used, but pure tone audiometry with tones starting at about 125 Hz and increasing by octaves, half-octaves, or third-octaves to about 8000 Hz is typical. Hearing tests of right and left ears are generally done independently. The results of such tests are summarized in audiograms¹².

However, in bone conduction the mechanical vibration coupled to the skull bone at mastoid process behind the external ear are used to stimulate cochlea through bone conduction. In reality, the bone conduction mechanism is far more complex. In addition to the direct mechanical pathway to cochlea there are three additional routes that may interfere^{12,15,16}. The vibration of the skull give rise

to relative motion of the ossicular chain, the middle ear component and also give rise to vibration of the walls of the external auditory canal which become significantly larger when the ear canal is occluded, e.g. by an earphone, a hearing aid of Pure tone audiometry is a simple diagnostic tool and easy to perform but give valuable information regarding degree, type, configuration of hearing loss and further management planning. So it should be routinely done in those patients complaining hearing impairment.

Materials and Methods

This cross sectional prospective study was carried out in the Audiology unit of the Department of Otolaryngology-Head and Neck Surgery, Combined Military Hospital, Dhaka, in a period of 06 months from o1 March 2016 to 31 August 2016 among those complaining hearing loss attending in this hospital. One hundred cases of hearing impaired people were taken and the informations were collected by interviewing the cases as per questionnaire from history, examinations and investigation reports. The clinically and by investigation proved cases of hearing impairment were included for the study. The patient having audiometrically proved normal hearing person and children below 4 years of age were excluded.

Some definitions:

- i. **Pure tone:** A single frequency sound is called a pure tone, e.g. a sound of 500, 1000, 2000 Hz.
- ii. **Frequency:** It is the number of cycles per second. The unit of frequency is Hertz (Hz) named after the German scientist Heinrich Rudolf Hertz. A sound of 1000 Hz means 1000 cycles per second. Frequencies of 500, 1000 and 2000 Hz is called speech frequencies because most human voice falls within this range.
- iii. **Decibel (dB):** It is 1/10th of a bel and is named after Alexander Graham Bell. It is a logarithmic unit and indicates ratio between two different intensities. One dB is equal to the least perceptible difference in sound detectable by human ear in frequencies concern with speech. In the clinical work the threshold of normal hearing is 0 dB.
- iv. **Threshold of hearing:** The threshold of hearing is defined at the level of a sound at which under specified conditions a person gives 50 percent of correct detection responses on repeated trials¹.
- v. **Degree of hearing loss measurement:**
 - Mild: 25-40 dB;
 - Moderate: 41-55 dB; Moderately Severe: 55-70 dB;
 - Severe: 71-90 dB
 - Profound :> 91 dB.

Results

The results are shown in tabulated form.

Table-I: Distribution of age among the study group (n=100)

Age (Years)	No of Patients	Percentage
0-10	06	06
11-20	12	12
21-30	30	30
31-40	16	16
41-50	12	12
51-60	14	14
>61	10	10
Total	100	100

Table-II: Distribution of sex among the study group (n=100)

Age group	No of patient	Percentage
Male	39	39
Female	61	61
Total	100	100

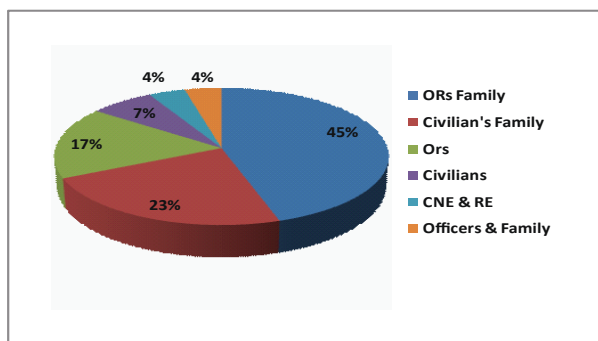


Fig-1: Pie chart occupation patterns of the patients in percentage
Note: ORs- Other Ranks, CNE-Civilians not Entitled, RE- Relative Entitled

Table-III: Distribution of presenting complaints (n=100)

Complaints	No of patients	Percentage
Hearing impairment	91	91
Itching in the ear	45	45
Ear discharge	43	43
Tinnitus	37	37
Blockage in ear	23	23
Earache	12	12
Vertigo	01	01

Table-IV: Degree of hearing loss among the patients

Degree of hearing loss	Right ear (n=90)		Left ear (n=86)	
	No. of patients	%	No. of patients	%
Mild	45	50.00	52	60.46
Moderate	27	30.00	20	23.25
Severe	10	12.22	08	9.30
Profound	08	8.80	07	8.13

From Table-IV, it is evident that 100-86=14 had only right ear hearing loss and 100-90=10 had only left ear hearing loss. So, 76 had both ear hearing loss.

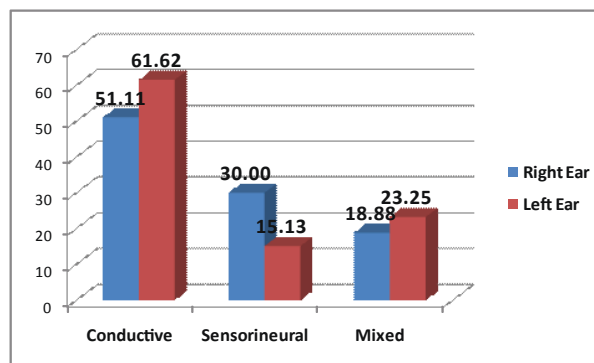


Fig-2: Bar diagram shows types of HL in percentage

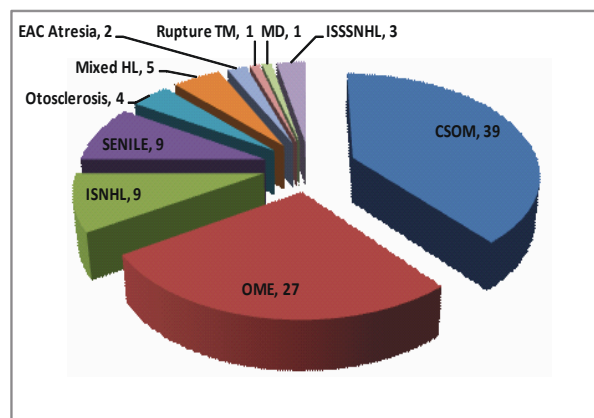


Fig-3: Causes of hearing loss in percentage

Discussion

Accurate assessment of hearing is fundamental to diagnosis, investigation, treatment and rehabilitation. Skilled testing by trained personnel in a suitable test environment is the key to diagnose the type, degree and other aspect of hearing impairment¹². The WHO estimated in 2005 that there were 278 million people worldwide with bilateral moderate to profound hearing loss, of whom 62 millions had deafness that began in childhood. Two-thirds of people with moderate to severe hearing loss live in the developing countries. South East Asia has the largest of hearing impairment in world and houses one-thirds of the hearing impaired population. WHO also estimates that every year about 38,000 deaf children are born in this region¹⁴. To treat the hearing impaired population correct assessment and diagnosis is a time need. For this purpose pure tone audiometry (PTA) is essential. PTA is the key hearing test used to identify hearing thresholds levels of an individual, enabling determination of degree, type and configuration of a hearing loss¹⁵. Thus providing the basis for diagnosis and management of a hearing impaired person.

Approximately 15% of the American adults (37.5 million) aged 18 and above report some hearing loss¹⁶. One in eight people in United States (13%, 30 million) age 12 or older has hearing loss in both ears, based on standard hearing examination¹⁷. British study shows that the prevalence of hearing impairment is 3.5% in the age group of 18-40 years, 17.4% in the age group of 41-60 years and 45.3% in the age group of 61-80 years¹⁸. In this study, patients in 21-30 years age group were most commonly affected and it was 30%. Next common age group was 31-40 years and 16% of the total patient were in this age group, followed by 51-60 years of age group 14%, 11-20 years of age group 12%, 41-50 years of age group 12%, more than 60 years of age group 10% lastly 0-10 years of age group in which there were only 06% patient. This study shows female sex was predominant, 61% female was affected by deafness in respect to 39% male.

The manual worker were 1.3 times more affected in conductive hearing impairment than the non-manual worker according to the result of British study¹⁸. This study reveals that ORs family (45%) were commonest group of people that are affected by deafness than civilians family (23%), ORs(17%) and followed by civilians (7%), CNE and REs (4%) and officers and family (4%).

In this study, 91% of the patients complained of hearing impairment, followed by itching (45%). As only hearing impaired people were included, naturally hearing impairment would be the most frequent complaint. From this study we got both ears were involved in disease process in 76% of the patients and only right ear was 14%, only left ear was 10%. So bilateral involvement were more common than unilateral.

The prevalence of adult middle ear disease in the British population was obtained from the UK national Study of Hearing, a randomly selected prospective clinical study. An otoscopic diagnosis was made from the sample of 2708 British adults¹⁸. The prevalence of healed, inactive and active COM (Chronic otitis media) was 12, 2.6 and 1.5 percent respectively¹⁸ and collectively 16.1%. From this study, it was found that CSOM was the commonest cause of hearing loss and it is 39%. In another study, a total of 686 children were interviewed and examined for CSOM with associated hearing loss in Yemen. The prevalence of CSOM of hearing loss was 7.4%¹⁹. The difference between that study from this one is due to the fact that they included all the people in their study but only the hearing impaired people were included in this study.

Zielhius et al reviewed a total of 23 studies showed age-specific prevalence rates of Otitis media with effusion (OME) up to ten years of age. The prevalence is bimodal with the first and largest peak of approximately 20% at two years of age. There is a second peak of approximately 16% at around five years of age when most children start attending a primary school²⁰. In this study second common cause of hearing impairment was OME and it was 27% of all cases. This study is almost similar with the study above mentioned.

ISSSNHL (idiopathic sudden severe sensorineural hearing loss) is one of the causes of hearing loss in Bangladesh. A number of Authors have proposed the definitions of ISSSNHL. One of the most adopted definitions is that of Wilson et al. that is at least 30 dB of hearing loss at three contiguous frequencies in less than three days. More recently, a retrospective cross-sectional study from Taiwan estimated the incidence at approximately eight per 100,000 per year²¹. From this study it was found 3 cases of ISSSNHL (idiopathic sudden severe sensorineural hearing loss), all were unilateral and left side was twice common than right ear involvement.

The next common cause of hearing loss is Otosclerosis. The British National Study of Hearing says overall prevalence of Otosclerosis is 2% (CI 1.5, 2.7) with equal distribution between male and female¹⁸. Otosclerosis was found from this study 04% (04) which is statistically significant with that study.

Age related sensorineural hearing loss is almost invariably inevitable. In an individual over age of sixty, with normal examination findings asymmetrical (often predominantly high-tone) hearing loss, a diagnosis of presbycusis or age related sensorineural hearing loss is fairly secure. In this study, four cases (09%) of presbycusis or age related sensorineural hearing loss was found. The dissimilarity between two studies because in perspective of Bangladesh the most of the cases of hearing loss remain undiagnosed as because of unawareness and unavailability of simple hearing test pure tone audiometry (PTA).

Browning GG et al showed that 16% of adults have mild (21-40 dB), 4% a moderate (41-60 dB) and 1% severe (61-80 dB) impairment in both ears. If only the poorer hearing ear is considered, 26% have a mild and 9% have a moderate and 4% have a severe

hearing impairment in that ear¹⁴. This study revealed that in right ear percentage of mild, moderate, severe and profound deafness as 50, 30, 12.22 and 8.88. In left ear percentage of mild, moderate, severe and profound deafness as 60.46, 23.25, 9.30 and 8.13 Browning GG et al also found that mild hearing loss is the commonest degree of hearing loss¹⁸ which is similar with this study.

Conductive type of hearing loss is the most common type. In the right ear 46 cases (51.11%) of conductive type of deafness, 17 cases (18.88%) of mixed type of deafness and 27 cases (30%) of sensorineural type of deafness and in the left ear 53 cases (61.62%) of conductive type of deafness, 20 cases (23.25%) of mixed type of deafness and 13 cases (15.13%) of sensorineural type of deafness is found. So it is noteworthy that commonest type of deafness was conductive as 51.11% of right ear and 61.62% of left ear showed this type of deafness.

Conclusion

In this study 100 cases of pure tone audiometry are evaluated among hearing impaired patients. Keeping it in mind, one has to realize that this may not be the exact picture of the population at large. All the data presented in this study may considerably vary with any large series but still then since the cases were collected very carefully over a period of six months from the above mentioned tertiary level hospital, the study might be of some credential in reflecting certain facts. Though ear diseases are common in Bangladesh but its diagnosis is usually delayed, till then certain amount of hearing loss has occurred. From this study it is clear that the commonest type of hearing loss is conductive type, commonest degree of hearing loss is mild degree (21-40 dB) and commonest causes of hearing loss are chronic suppurative otitis media (CSOM) and otitis media with effusion (OME). As ear diseases are common in this country and commonest type, degrees are milder form and most of the causes are preventable. So we should all together take appropriate steps to curb down the preventable hearing impairment.

References

1. Katz J, levy RG. Spondiac procedures in central testing. In: Katz J (ed). Handbook of clinical audiology, 4th ed. Baltimore: Williams ET Wilkins 1994:239-55.
2. Jerival L, Arlinger S. A comparison of 2 and 57 dB step size in pure tone audiometry. *Scandinavian Audiology* 1986; 15:51-6.

3. ISO 389-1. Acoustics-Reference zero for the calibration of audiometric equipment. Part-1 Reference equivalent threshold sound pressure levels for pure tones and supraural earphones. Geneva: International Organization for Standardizations.
4. Sohmar H, Freeman S. Further evidence for a fluid pathway during bone conduction auditory stimulation. *Hearing Research* 2004; 193:105-10.
5. ISO 8253-1. Acoustics-Audiometric tests methods Part 1-Basic pure tone air and bone conduction thresholds audiometry. Geneva: International organization for Standardization.
6. Nilsson M, Soli SD, Sullivan JA. Development of the Hearing in noise test for the measurement of speech reception thresholds in quiet and in noise. *Journal of the Acoustical Society of America* 1994; 95:1085-99.
7. Wagener K, Josvassen JL, Ardenkjaer R. Design, optimization and evaluation of a Danish sentence test in noise. *International Journal of Audiology* 2003; 42:10-47.
8. Larsby B, Arlinger S. Speech recognition and just follow conversion task for normal hearing and hearing-impaired listener with different masker. *Audiology* 1994; 33:165-76.
9. Tarsby B, Grlinger S. Speech recognition and just for-follow -conversion task for normal hearing and hearing impaired listeners with different masker. *International Journal of Audiology* 2006; 64:564-83.
10. Baer T, Moore BCJ, Gatehouse S. Spectral contrast enhancement of Speech in noise for listeners with sensorineural hearing impairment: Effect on intelligibility, quality and response times. *J Rehabil Res Dev* 1993; 30(1):49-72.
11. Lunner T. Cognitive function in relation to hearing aid use. *Int J Audiol* 2003; 42(Suppl 1):S49-58.
12. Michael Gleeson: Scott-Browns, Otolaryngology and Head-Neck Surgery; 7th ed; Hodder Arnold 2008; 3:3261-75.
13. PL Dhingra; Diseases of Ear Nose and Throat; 3rd ed; Elsevier 2004; 31-33.
14. Nasima A, Pran GD, Alauddin M. Neonatal Hearing Screening. *Bangladesh J Otorhinolaryngol* 2010; 16(1):54-9.
15. http://en.wikipedia.org/wiki/pure_tone_audiometry
16. Blakwell DL, Lucas JW, Clarke TC. Summary of health statistics for USA adults: National centre for health Statistics. *Vital health Stat* 2014; 10(260):1-161.
17. Lin FR, Niparko JK, Ferrucci L. Hearing loss prevalence in United States. *Arch Intern Med* 2011; 171(20):185-2.
18. Browning GG, Gatehouse S. The prevalence of middle ear disease in the adult British population. *Clin Otolaryngol Allied Sci* 1992;17(4):317-21.
19. Muftah S, Mackenzie I, Faragher B et al. Prevalence of CSOM and associated hearing impairment among school aged children in Yemen. *Oman Medical journal* 2015; 30:358-65.
20. Zeilhuis GA, Rach GH, Van Den Bach A et al. The prevalence of otitis media with effusion: A critical review of literature. *Clin Otolaryngol Allied Sci* 1990; 15(3):283-8.
21. Wu CS, Lin HC, Chao PZ. Sudden sensorineural hearing loss: evidence from Taiwan. *Audiol Neurootol* 2006; 11(3):151-6.