

Original Article

Audiological evaluation in geriatric age group

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Abstract

Introduction: Age Related Hearing Loss (ARHL) is defined as loss of hearing in elderly persons not influenced by the extraneous factors like noise trauma etc or intrinsic like CVS related diseases or endocrinal disorders like Diabetes. Also termed as Presbycusis it is defined as the loss of hearing due to age related changes taking place in the auditory system starting from the pinna to the cortical centers in the brain. It does not include any other factor contributing or initiating the pathological changes in the auditory system resulting in hearing loss. All these changes in the tissues are not pathological but truly age related. The study also includes the review of the literature on ARHL.

Materials and Methods: 185 individuals aged above 65 years are evaluated for hearing thresholds with the help of pure tone audiometry and speech audiometry. Among the 185 individuals 102 are patients attending the Department of ENT for the complaints of loss of hearing. The remaining 83 individuals are from the survey conducted to screen for hearing loss in the city of Thiruvananthapuram for the population aged above 65 years. Demographic data about the 185 individuals is collected. Pure tone audiogram and speech audiometry is done in all the patients.

Conclusions: PTA and SRT values are similar in both the groups. Early old age groups presented with mild to severe types of deafness and loss in lower frequencies. Late old aged people showed profound hearing loss and increased thresholds in higher frequencies. SRT estimation seemed more sensitive than calculating PTA in the persons above 85 years. Females showed 5 to 10 dB lower PTA values than males in all ages.

1. Introduction

The incidence of Hearing Loss in Geriatric population is found to be increasing in all the strata of the society in India. This incidence is more so evident in the states of India where the longevity of the population is beyond 80 years like in Kerala. The effects of ageing on the auditory system are multi focal. Age related Hearing Loss (ARHL) or presbycusis is one among the commonly reported health problems in India and a commonest cause of Hearing Loss. Auditory system being the important link to communication, its loss is detrimental to inter personal relations among the family members, social contacts and quality of life in many aged persons. Audiometric features of ARHL vary from pure conductive deafness to symmetrical, high frequency sensorineural hearing loss. In few the pure tone audiograms show a relatively flat graph over all the frequencies. Most of the aged persons may have a well preserved hearing. [1] One of the most important factor causing impaired speech reception and detection is peripheral hearing loss. [2,3] In a small group of individuals the cause of severe hearing loss may be due to Central auditory dysfunction and cognitive problems. [4,5] It is difficult to identify and separate the cognitive and perceptual processes in elderly people. Epidemiological studies on hearing (calculated from PTA across the frequencies of 0.5 -4 KHZ) from different developed, post-industrialized western countries showed that younger age groups had no evidence of hearing loss; middle age groups showed mild hearing loss and elderly age groups showed severe hearing loss. The studies from these countries had a reasonable coincidence in findings. The studies include few from Nordic countries [6-11], European countries [12, 13], North America [14, 15] and Australia [16]. Even though India, China and Brazil contribute the major chunk of world's population epidemiological studies related to hearing loss are not worth mentioning. [17] In a study by Liu *et al* from China it was found that the prevalence of hearing loss in aged persons was lower than the Swedish and other European countries. [18] Similar studies from Brazil showed equal to or even better hearing in elderly people than the Swedish study. The present study is an attempt to evaluate the hearing thresholds in patients coming to the department of ENT with complaints of HL and assess HL in the elderly persons by conducting a screening survey.

2. Materials and Methods

Out of 185 persons, 102 are patients aged above 65 years attending the department of ENT with the complaints of loss of hearing to the Government General Hospital attached to Government Medical College, Thiruvananthapuram, Kerala between 2007 and 2010. The remaining 83 are the persons screened for hearing loss in the city of Warangal during a survey. These patients did not complain of impaired hearing, but are screened during the survey for assessment of hearing in elderly. Pure Tone Average and Speech Reception Threshold are assessed for these patients. Patients are included in the study based on inclusion and exclusion criteria.

2.1 Inclusion criteria

Patients aged above 65 years with or without impaired hearing; Patients with history of impaired speech reception; Patients with associated symptoms of tinnitus.

2.2 Exclusion Criteria

Patients aged below 65 years. Patients with impaired hearing associated with professional noise trauma and diabetes mellitus. Patients with impaired hearing associated with active or healed middle ear disease. Patients with impaired hearing associated with CVA or TIA. After recording the demographic data all the patients are subjected to ENT examination. All the patients are classified into separate age groups with a class interval of 10 years. Pure tone audiometry is done in all patients with frequencies from 500 KHZ to 8000 KHZ. Pure tone average (PTA) is calculated for three consequent speech frequencies (55, 1000, and 1500). Hearing impairment is graded as mild: hearing loss: 26-40 dB HL. Moderate hearing loss: 41-55 dB HL, moderate to severe hearing loss: 56- 70dB, severe hearing loss: 71-90dB and profound hearing loss: 91 dB and above. Speech audiometry is done with 25 phonetically balanced words with 2 consonants and one vowel. Speech reception thresholds above 90% are taken as normal. 80 to 90% of SRT is taken as mild hearing loss, 60 to 80% is taken as moderate hearing loss and less than 60% is taken as profound hearing loss. All the data is analyzed using standard statistical methods to know the significance of the study.

3. Observations

Totally 185 persons out of whom 102 patients attending the ENT OPD of Government Hospital attached to Medical College, Thiruvananthapuram, Kerala and 83 persons from the survey for screening the hearing loss in elderly are included in the present study. The selection of the patients is done according to the inclusion and exclusion criteria. Among the 185 persons 105 are male and 80 are female, with male to female ratio of 1.31: 1 with a male preponderance (Table1). The youngest patient is 65 years and the oldest patient is 92 years with a mean age of 76.79 years, the median is 75 and the mode is 68. Taking the hypothetical mean of age as 75, single sample T test is applied to know the statistical significance of the data and found that the sample of the present study is significant with T value 2.763 And P-value 0.00315 which is significant at P<0.05. To observe the difference in results of audiological assessment between the Hospital patients and persons from the survey for screening for HL screening they are grouped as GROUP A and GROUP B respectively. In 102 patients of group A, males are 56 (54.905) and females are 46 (45.09%) with sex ratio of 1.21:1 with male preponderance (Table 2). The youngest patient is 65 years and the eldest is 90 years old with Mean age 76.86, Median 75 and Mode is 68. Single sample T test showed that the data studied in group A is statistically significant with T value 2.164 and P-value 0.016 (P value at <0.05). In group B males are 49 (59.03%) and females are 34 (40.96%) with a male to female sex ratio of 1.44:1 with male preponderance (Table 3). The youngest patient is aged 67 years and the eldest is 92 years with the mean 76.71, Median 76 and Mode is 66. Single sample T test showed that the data studied in group A is statistically significant with T value 1.720 and P-value 0.044 (P value at <0.05).

Table 1: Showing the Sex incidence (n=185).

SEX	Male	Percentage	Female	Percentage
Number of Patients	105	56.75%	80	43.24%

Table 2: Showing Sex incidence in group A (n=102).

SEX	Male	Percentage	Female	Percentage
Number of Patients	56	54.90%	46	45.09%

Table 3: Showing Sex incidence in group B (n=83).

SEX	Male	Percentage	Female	Percentage
Number of Patients	49	59.03	34	40.96

In group A 55 (53.92%) patients out of 102 showed PTA more than 56dB, and among them males are 30 (54.54%) and females are 25 (45.45%). Similarly in group A mild HL with PTA 26 – 55 dB is seen in 47 (46.07%) patients and among them males are 27(57.44%) and females are 20 (42.55%)-(Table 4). In group B 47 (56.62%) out of 83 persons showed HL more than 56dB, out of them males are 28 (59.57%) and females are 19 (40.42%). In this group mild HL with PTA from 26-55dB is seen in 36 (43.37%) persons, and among them males are 19 (52.77%) and females are 17 (47.22%)-(Table 5). In group A patients HL more than 56dB, in the age group of 65- 74 is seen in 19 (18.62%), in the age group of 75-84 is 23 (22.54%) and in 85-94 age group it is 13 (12.74%). In group B persons with more than 56dB loss belonging to the age of 65-74 are 15 (18.07%), 75-84 are 26 (20.48%), and 85-94 are 15 (18.07%) - (Table 5). In group A 55 patients showed PTA more than 56 dB when compared to the SRT values 63 patients showed 60 to 80% and less than 60% and similarly in group B the difference between PTA : 47 and SRT: 57. PTA values in this study groups did not coincide with the SRT assessment. It could be that speech audiometry is a better assessment test than PTA in reaching a final decision making in the diagnosis of ARHL.

Table 4: Showing the incidence of hearing loss (PTA) in different age groups in group A (n=102).

Age Interval	Mild HL: 26-40 dB. (24)		Mod HL: 41-55 dB. (23)		Mod- Severe HL: 56-70 dB. (23)		Severe HL: 71-90 dB (21)		Profound HL: 91 dB->91 dB (11)	
	M	F	M	F	M	F	M	F	M	F
Sex: M56 F46										
65-74 Yrs	06	04	05	03	05	03	05	04	01	01
75-84 Yrs	05	03	05	05	04	05	05	04	03	02
85-94 Yrs	03	03	03	02	03	03	02	01	02	02

When the two groups are compared based on the PTA values for the different grades of HL, applying student T test it is found to be not significant with T value 1.3444 and P value 0.144 (predicted P-at<0.05). That means whether the auditory assessment is done in a Hospital setting where the patients approach for a remedy for HL or

assessment done in a survey reaching out to the elderly, the results from the sample is similar. The T value calculated for the SRT results in group A and B is 0.736 and the P value is 0.489 which is not significant (Table 4, 5).

Table 5: Showing the incidence of hearing loss (PTA) in different age groups in group B (n=83).

Age and Sex Interval	Mild HL: 26-40 dB. (17)		Mod HL: 41-55 dB. (19)		Mod- Severe HL: 56-70 dB. (22)		Severe HL: 71-90 dB (17)		Profound HL: 91->91 dB (08)	
	M	F	M	F	M	F	M	F	M	F
Sex: M49 F34										
65-74 Yrs	03	05	03	02	05	04	02	02	01	01
75-84 Yrs	03	02	05	04	04	03	04	03	02	01
85-94 Yrs	02	02	03	02	04	02	04	02	02	01

In group A SRT between 60- 80% to less than 60% is seen in 63 (61.76 %) patients, among them 15 (14.70%) belonged to the age group of 65-74, 21 (20.58%) to age of 75-84 and 27 (26.47%) to the age group of 85-94. In group B similarly 57 (68.67%) out of 83 patients

showed SRT between 60-80-% to less than 60%, among them 13 (1.66%) belonged to the age group of 65-74, 20 (24.09%) belonged to the 75-84 age group and 24 (28.91%) belonged to the age of 85-94 (Table 6, 7).

Table 6: Showing the incidence of speech reception thresholds in group A (n=102).

Age and Sex Interval	Normal SRT >90% (14)		Mild HL SRT 80-90% (25)		Moderate HL SRT 60-80% (31)		Profound HL SRT <60% (32)	
	M	F	M	F	M	F	M	F
Sex: M56 F46								
65-74 Yrs	01	01	03	03	04	03	05	03
75-84 Yrs	02	03	03	05	07	03	08	03
85-94 Yrs	02	05	04	07	08	06	09	04

Table 7: Showing the incidence of speech reception thresholds in group B (n=83).

Age and Sex Interval	Normal SRT >90% (8)		Mild HL SRT 80-90% (18)		Moderate HL SRT 60-80% (30)		Profound HL SRT <60% (27)	
	M	F	M	F	M	F	M	F
Sex: M49 F34								
65-74 Yrs	03	01	03	03	04	03	04	02
75-84 Yrs	02	02	05	02	06	05	06	03
85-94 Yrs	--	--	02	03	07	05	07	05

Audiological assessment in both the group A and B showed no significant difference in the outcome of results in terms of PTA or SRT thresholds both age wise and sex wise. Pure tone thresholds of

higher frequencies 3KHZ to 8KHZ increased with the increase in age in both the groups. Pure tone thresholds in females are 5 to 10 dB less than the males in all higher frequencies (Table 8).

Table 8: Showing the percentage of High frequency Pure tone audiogram HL in both A&B groups (n=185).

Groups	Frequencies	3000KHZ		4000KHZ		6000KHZ		8000KHZ	
		A	B	A	B	A	B	A	B
Age		dB	dB	dB	dB	dB	dB	dB	dB
65-74 Yrs	Male	35	30	45	50	60	65	75	75
	Female	30	25	50	50	70	75	65	70
75-84 Yrs	Male	50	40	55	55	85	80	95	90
	Female	50	45	55	50	80	75	75	80
85-94 Yrs	Male	40	35	60	65	80	80	95	95
	Female	45	35	65	65	85	75	80	85

4. Discussion

The phenomenon of increase in elderly populations is observed worldwide. As there is a vast information regarding hearing in geriatric age groups in western countries, very little is available in the eastern countries. A majority of the world's population lives in countries that are in a process of rapid industrialization and economical development. Some of these countries have very large populations, like China, India and Brazil. In spite of the fact that a large proportion of the world's population lives in these countries, information of many health sectors, like audiology services, is not forthcoming. [20] Hearing thresholds when compared between males and females aged 70-80 years, it is found in a study by Jerger J *et al* that in males the loss is more in higher frequencies (4KHZ) than females by 10-20dB. In the present study the thresholds of hearing in higher frequencies from 3KHZ to 8KHZ is comparatively 5 to 10dB more in males than in females. But after the age of 80 years the difference is smaller than 5-10 dB. In low frequency range females showed poorer thresholds than men. [21]

In animal studies there was no gender difference found. [22] In a study by Goycoolea *et al* there was no gender difference in hearing thresholds of aged people in Easter Island and their hearing was well preserved. [23] There was loss of hearing in the countries of Surinam and Amerindians' just like industrial societies. Age related changes in the micro structure of the auditory system especially cochlea are reported in animals and human beings in the literature. [24] The brunt of the degeneration is seen in the two type's hair cells of the basal turn of the cochlea. [25] It is described as Patchy degeneration of outer Hair cells (OHC) of both cochlear apical and basal turns. Whereas degeneration of Inner hair cells, cochlear nerve fibres are mostly confined to basal turn of the cochlea. After 50 years as the age progresses the degenerative changes occur in a severe form in OHCs rather than IHCs. Similar changes are seen in the spiral ganglion in the form of atrophy and osseous spiral lamina. Electron microscopic pictures show formation of giant cilia and derangement of micro cilia are reported from the aged human inner ears. In the present study mild to moderate HI with PTA ranging from 26 to 55dB are seen in early stage (65 to 74 years) of old age and Higher frequency HL is seen in later stages (75 to 94 years) of old age. [27]

Degenerative changes in the form of loss of loss of neurons especially in cochlear nerve nuclei and central neuronal pathway of auditory system with increasing age is reported in the literature, but this is challenged, hence the HPE changes in inner ear are now given importance. SRT values below 60 to 80% and below 60% seen in the age groups of 75-84 and 85- 94 seen in the present study can be explained to loss of neurons in the auditory pathway. Similarly increase I the PTA seen in age groups of 65-74 and 75-84 can be explained due to loss of hair cells in the peripheral part of the auditory system. [28] Six

types of ARHL based on HPE findings correlated to audiological assessment are described by Schuknecht and Gacek[26]: 1. Loss of sensory hair cells, supporting cells and neuronal cells of the basal turn of the cochlea; audiological assessment showing high frequency loss with relatively normal speech perception is termed as Sensory Presbycusis. 2. Loss of neurons more than the sensory hair cells in the entire spiral ganglion, but severe in basal turn; audiological assessment showing reduced speech recognition in relation to pure tone audiogram is termed as Neuronal Presbycusis. 3. The entire Cochlea showing patchy atrophy of stria vascularis, but more damage in middle and apical turns; audiology assessment showing flat audiogram with slow progression of hearing loss and good speech recognition ability is termed as strial Presbycusis. 4. A combination of the above described pathological changes is termed as mixed type of Presbycusis.5. A hypothetical distortion of the mechanics of the spiral ligament is termed as conductive Presbycusis. 6. No morphological changes detectable by light microscopy are termed as indeterminate Presbycusis.

Studies related to find the causes of ARHL show that the process is a multifactorial one and not possible to separate the different constituents from one another. One of the obvious causes is biological ageing resulting in degeneration of hair cells and neurons which is not reversible and is called as intrinsic factor. As this process starts late in the age; can be used to explain the hearing loss ARHL. In the present study PTA and SRT values are similar in both the groups irrespective of the sex and age groups. It is proposed that the term Presbycusis should be used only to denote the normal ageing process not influenced by hormonal, noise or drug induced hearing loss. General neuronal degeneration of the brain is one more factor related to ARHL and not entirely too central auditory degeneration. [30] As few people have reasonably well preserved hearing in advanced age compared to others, it is proposed that a genetic factor might be determining the hearing ability. While others have a sloping air conduction curves I audiogram even during middle age. Genetic factors are usually run in families and result in early onset of HL and affect many members of the same family. [31] These familial aggregations are correlated to sensory and strial ARHL phenotypes, but the hereditary nature is more for strial type than sensory type of degeneration. This study also reported that females seem to have more pronounced genetic factor in the multifactorial ARHL. [18] In a study by Liu *et al* in China the genetic cause was seen in 8% of the total 4164 persons evaluated for their hearing. [32] Ahl (Age related hearing loss gene) genes in mice located on chromosome 10 and [33] a gene on chromosome 3q in humans are linked to ARHL. [34] Recently mitochondrial DNA deletions (mt DNA) gene is proposed to be associated with ARHL. A majority of them showed a 4977 bp deletion. Presbycusis precludes hearing loss only due to organic changes in the auditory system due to aging process, but noise exposure acts as an external factor which affects hearing in the elderly more so in men. The

interaction of these two factors are a complex mechanism causing HL and difficult to understand. Presbycusis may add up to permanent threshold shift seen in Noise induced hearing loss. [35]

ARHL is also influenced by many other factors like ototoxic drugs, smoking, head injury, CVS disorders and ontological diseases. [36] Demographic factors like socio-economic state, education and state of health interfere with ARHL. Prevention of ARHLK is possible if there is early control of noise exposure in one's life. Suggestion of good diets, anti oxidants, change in life styles e.g. smoking and prevention of CVS diseases play an important role in prevention of SARHL. Further studies are required in India to evaluate hearing loss in elderly persons on a larger scale to understand the causes, its progression and modes of re-habilitation.

5. Conclusions

A small sample survey of hearing assessment among the elderly shows HL more than 56dB of PTA and SRT below 60%-80% is seen in more than 50% of the male persons and more than 40% of the females. It shows the population at risk of developing HL and requires treatment and re-habilitation. There is no statistical significant difference in the assessment results in Hospital patients or survey persons. Female persons tend to have lower threshold levels in speech frequencies when compared to males. Higher frequency losses more in individuals are in the age groups of 85 to 94 years. Larger survey samples are required to pin point the causes of HL in geriatric age and its correlation with the Histopathological findings.

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