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Original Article

An Analysis of Impedance Audiometry in Geriatric Patients with Hearing Loss - A Hospital-based Study

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Abstract

Background: The causes of hearing loss (HL) in geriatric patients are many and in view of the ever-changing theories of mechanism of hearing require thorough clinical and scientific study to understand the same.

Aim of the Study: This study aims to analyze the results of impedance audiometry in geriatric patients to understand the organic changes in the ear related to aging.

Materials and Methods: A cross-sectional, prospective, and comparative study of geriatric patients with HL managed at ENT OPD. Initially, a structured questionnaire was used to gather the clinical information followed by audiological evaluation. Intergroup differences of the study group were performed using clinicoaudiometric findings such as middle ear pressures, acoustic reflexes, and tympanograms.

Observations and Results: A total of 90 geriatric patients with HL were included; 53 (58.88%) were males and 37 (41.11%) were females with male-to-female ratio 1:1.43; age group of 61–89 years with a mean age of 72.35 ± 4.26 years. Tympanometry showed conductive deafness in 46/90 patients (51.11%); these patients showed abnormal tympanograms; Type B (09), C (16), "As" (14), and "Ad" (07). Pure tone average (PTA) above 20 dB was observed in 66/90 patients (73.33%). PTA values of more than 20 dB were observed in 66/90 patients. Absent acoustic reflexes were seen in 29/90 patients (32.22%).

Conclusions: Impedance audiometry abnormalities were demonstrated in few of the geriatric patients with HL which were significantly associated with parameters related to organic changes of aging. It is necessary that elderly patients with HL should have both their inner and middle ear function assessed with suitable gadgets, to manage them optimally.

Key words: Audiometry, Conductive, Geriatric, Hearing loss, Sensorineural and mixed hearing loss

INTRODUCTION

The theories of hearing mechanism explain complex and concurrent interplay of several parts of the ear resulting in conduction of sound waves from the environment through the external auditory canal; vibrating the tympanic membrane; transformer mechanism of the middle ear ossicles, and finally, the piezoelectric effect of hair cells of cochlea converting the mechanical energy to electrical energy. The electrical waves so generated are transmitted to the auditory cortex for final analysis and appreciation. Organic changes occurring in the body due to aging process also occur in the ear resulting in hearing loss (HL) otherwise called as "presbycusis." HL is considered as the most common aging process affecting the neuronal systems in the body.[1] Few studies have suggested that sensorineural HL accounts to one-third of the total HL causes in the geriatric age groups (61–70 years).[2] In excess of 80% of geriatric aged beyond 85 years has clinically obvious difficulty understanding the speech and following conversations in the presence of background noise.[2,3] The hearing threshold increases by 1 dB/year on an average for patients aged 60 years and above.[4] They also develop a tendency to further deterioration with increasing age.[4] The pure tone averages (PTA - average of minimum threshold hearing at 500, 1000, and 11,500 KHz) studied in one

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scientific paper was shown to be ≥ 25 dB in 35% of the patients aged 60 years and may increase further to 50% in the age group between 70 and 80 years.[5] The prevalence of HL in geriatric patients varies in different location of the world, but it was established that HL increases certainly after 60 years.[6] The HL in geriatric patients is in similar lines such as conductive, sensory, neural, or mixed types. The organic changes that occur in tympanic membrane, ligaments of the ossicle, ossicles proper and inter ossicular joints, hair cells, and neurons of the auditory nerve are well recorded.[7] In the cochlea, they include loss of sensory hair cells of the cochlea consequent on generalized degenerative processes, dysfunction of the stria vascularis (the main blood supply to the organ of Corti), and degeneration of the neurons of the cochlear nerve or its central connections.[7] In the external ear, wax impaction in the external auditory meatus has been reported to be disproportionately more common in the elderly patients than in other groups of patients, causing conductive HL; morphological changes in the head of the mandible and angle of mandible (more obtuse) leads to distortion of the external auditory canal is explained the cause of wax impaction resulting in conductive deafness;[8] the degenerative changes in epithelium of the skin lining the external auditory canal without an accompanying reduction in the rate of wax production may another explanation given. Few authors have observed changes in the dynamic characteristics of the middle ear contents, especially the mucosal folds, ligaments, and ossicles proper affecting the middle ear transformer mechanism.[9,10] These observations would have been possible from different types of instruments applied in measuring the hearing acuity recently.[11,12] In the present study, as a hospital-based survey of HL in geriatric patient's audiological evaluation was done using pure tone audiometry, impedance audiometry, acoustic reflexes, and tympanograms.

Aim of the Study

This study aims to analyze the results of impedance audiometry in geriatric patients to understand the organic changes in the ear related to aging.

Study Period

The period of study was from July 2015 to June 2017.

Institute of Study

The study was conducted at Kurnool General Hospital Attached to Kurnool Medical College, Kurnool, Andhra Pradesh.

MATERIALS AND METHODS

The present study is a hospital-based cross-sectional, prospective, and comparative study conducted on 90 geriatric patients (aged above 60–90 years) attending the ENT OPD for complaints of HL lasting for more than 6 months.

Inclusion Criteria

1. Patients aged above 60 years are included.
2. Patients with HL for more than 6 months duration are included.

Exclusion Criteria

1. Patients below 60 years were not included.
2. Patients who have undergone any type of ear surgery previously were excluded.
3. Patients with middle ear diseases were excluded.
4. Patients on injection streptomycin previously were excluded.
5. Patients with complaints of vertigo were excluded.
6. Patients with diabetes mellitus and women with a history of eclampsia were excluded.

Institutional Ethical Committee clearance certificate was obtained. Ethical Committee approved consent form and questionnaire were only used in the study. The general nature, significance, and requirements of the patients, including the fact that declining to participate in the study would not affect treatment, were explained to the patients. The questionnaires were prepared to have three parts; Part A: Questions related to sociodemographic information, Part B: Medical complaints related to hearing, history of present illness HL, duration of hearing impairment, and present or previous ear surgeries; and Part C was otoscopy findings and records of the audiometric profiles of the patients, which included the PTA, tympanometry, and acoustic reflexes. The acoustic reflex thresholds were tested with contralateral stapedial reflexes for frequencies of 500, 1000, 2000, and 4000 Hz; the thresholds were considered as normal when elicited between 75 and 110 dB HL. The tympanograms were classified according to Jerger Types A, As, Ad, B, and C; 14 with Type A considered as normal, and any other tympanogram types as abnormal, while acoustic reflexes were classified as present or absent. All the data were analyzed using standard statistical method; analyzed using Chi-square test, while continuous variables, presented as absolute values and means, were compared using Student's *t*-test. The level of statistical significance was set at $P < 0.05$. Data analysis was performed using socialsciencestatistics.com online.

OBSERVATIONS AND RESULTS

A total of 90 geriatric patients were included in the present study. Among them, 48 (53.33%) were males and 42 (46.66%) were females with male-to-female ratio 1:1.43. Patients belonged to the age group of 61–89 years with a

mean age of 72.35 ± 4.26 years. 61 patients (67.77%) were above 70 years of age in the study [Table 1].

Among the 90 subjects, 45 males were married and 40 females were married. The demographic data and social status are shown in Table 2.

Pure tone audiometry showed normal PTA in 09 patients (10%), 15 to 20 dB loss of hearing in 15 patients (16.66%), 20 to 30 dB loss in 18 patients (20%) and 30 to 40 dB loss in 36 patients (40%), and 1 above 40 dB loss in 10 patients (11.11%) [Table 3].

The types of tympanograms observed in this study included Type A in 44 patients (48.88%), Type B in 09 (10%), Type C in 16 (17.77%), Type As in 14 (15.55%), and Type D in 07 (7.77%) [Table 4].

In the present study, acoustic reflexes were present in 61 patients (67.77%) and absent in 29 patients (32.22%) [Table 5].

Table 1: The age and gender incidence of the study group (*n*=90)

Age groups (years)	Male *n*=48	Female *n*=42	Total (%)
61–70	17	12	29 (32.22)
71–80	24	21	45 (50)
81–90	07	09	16 (17.77)

Table 2: The sociodemographic data of the study group (90)

Demographic observations	Male *n*=48 (%)	Female *n*=42 (%)
Married	45 (50)	40 (44.44)
Unmarried	03 (6.66)	02 (2.22)
Illiterate	02 (2.22)	04 (4.44)
Formal education	16 (17.77)	18 (20)
Graduates	20 (22.22)	14 (15.55)
Postgraduates	10 (11.11)	06 (6.66)
Skilled	14 (15.55)	11 (12.22)
Semi-skilled	18 (20)	10 (11.11)
Professionals	16 (17.77)	19 (21.11)

Table 3: The PTA values in the study group (*n*=90)

PTA in dB	*n* (%)
Normal	09 (10)
15–20	15 (16.66)
20–30	20 (20)
30–40	36 (40)
Above 40	10 (11.11)

PTA: Pure tone average

Table 4: The types of tympanogram observed (*n*=90)

Type of tympanogram	*n* (%)
Type A	44 (48.88)
Type B	09 (10)
Type C	16 (17.77)
Type AS	14 (15.55)
Type D	07 (7.77)

Table 5: The incidence of acoustic reflexes present in the study (90)

Acoustic reflexes	*n* (%)
Present	61 (67.77)
Absent	29 (32.22)

DISCUSSION

Organic changes in all parts of the ear due to aging are mentioned in all the standard textbooks. The changes are in external auditory canal causing narrowing which is in turn due to changes in the angle of the mandible and wearing out of the head of the mandible.[8] Changes in tympanic membrane include opacification of the periphery of the membrane due to collagen deposition in the fibrous layers.[12] Age-related changes are described in the ligaments of ossicles, and the osteoporosis of the ossicles proper[8] is likely to cause conductive deafness affecting the lower frequencies. In the present study, elderly patients presenting with complaints of HL, difficulty in understanding speech, and difficulty in appreciating the fine-tuning of speech were subjected to audiological evaluation. It was observed that there were few abnormal audiometry findings in PTA, tympanometry graphs, and acoustic reflexes. Many researchers have focused on sensorineural component of HL in geriatric patients and ignored the conductive component of HL. In the present study, the audiometry values point to conductive deafness; in 46/90 patients (51.11%); these patients showed abnormal tympanograms; Type B (09), C (16), As (14), and Ad (07). PTA above 20 dB was observed in 66/90 patients (73.33%) [Table 3]. However, these observations would not conclusively ascertain whether these middle ear abnormalities were due to aging process, or mere coincidental findings. Nondahl *et al.*[13] reported a small degree of middle ear stiffening occurring over the years among older adults. An animal experiment by Doan *et al.* also found structural changes in the middle ear of aging mouse that was attributable to aging.[14] In the present study, there was no statistical significance between the ages of normal geriatric patients and those with abnormal tympanogram graphs and acoustic reflexes. In the present study, the acoustic reflexes were absent in 29/90 (32.22%) of the patients [Table 5]. In a study by Gaihede and Koefoed-Nielsen,[15] the comparison between compliance and middle ear

Table 6: The correlation between PTA and impedance values in the study (n-90)

Age Groups	PTA		Type of Tympanogram			Acoustic reflexes		*P* value
	30-40 dB -36	>40dB -10	B 9	C- 16	Ad 07	+ 61	– 29	0.048
61 to 70 Yrs	07	03	01	03	03	21	11	0.038
71 to 80 Yrs	16	05	02	09	03	19	10	0.035
81 to 90 Yrs	13	02	06	04	01	21	08	0.045

PTA: Pure tone average

pressure measured by tympanometry between normal geriatric patients (with mean age 77 years) and normal younger patients (with mean age 29 years) showed that the middle ear compliance was not influenced by variation in age. There was no association found between the gender of the patients and middle ear mechanics analogous to findings of the blue mountains hearing study in Australia.[16] The observations made in the present study related to middle ear mechanisms were comparable to the similar reports prevalence of age-related HL.[17] This would also suggest that the middle ear changes and inner ear changes due to the age-related organic aging process would have simultaneous and concurrent effect on hearing. "As" type of tympanogram was observed most frequently in China among the centenarians with HL, which may be as a result of increased stiffness (decreased compliance) of the conductive mechanism.[12] This is followed by Type "C" curve suggesting a eustachian tube abnormality among the geriatric patients.[18] Golding *et al.* concluded that sometimes abnormalities occur in the tympanic membrane and in the bony ossicles, resulting in significant middle ear functional impairment.[16] An evidence of loss of vascularization, a reduction in collagen structure, elasticity, and greater rigidity of the middle fibrous layer of tympanic membrane was demonstrated by Ruah *et al.*[12] One study by Nixon *et al.* showed PTA changes amounting to more than 15 dB losses in elderly patients.[19] In the present study, similar values were observed. The possibility of osteoarthritis of ossicular joints producing "AS" type of tympanogram may also have to be considered in the geriatric patients.[8] The pathway involved in the acoustic reflex is complex and can involve the ossicular chain, cochlea, auditory nerve, brain stem, facial nerve, and other components. The absence of acoustic reflex has been shown to effectively detect HLs exceeding 30 dB in adult subjects.[20] In the present study, the patients showing absent acoustic reflexes were having abnormal PTA values and Type B and AS type of curves of tympanograms in 29/90 patients (32.22%). The limitations of this study are the lower sensitivity of the conventional tympanometer in assessing middle ear function compared with sweep frequency middle ear analyzer. The lesser incidence of absent acoustic reflexes was not explainable even though the incidence of higher PTA values was observed in 66/90 patients. Moreover, a hospital-based study is prone to bias. Despite these limitations, the study was able to demonstrate that the middle ear functioning of elderly patients may not be fully normal. The correlation between the pure tone audiometry findings and their corresponding impedance audiometry findings and values are tabulated in Table 6. AQ1

CONCLUSION

Impedance audiometry abnormalities were demonstrated in few of the geriatric patients with HL which were significantly associated with parameters related to organic changes of aging. It is necessary that elderly patients with HL should have both their inner and middle ear function assessed with suitable gadgets, to manage them optimally. Community-based longitudinal studies are needed to further clarify these findings.

REFERENCES

1. Van Eyken E, Van Camp G, Van Laer L. The complexity of age-related hearing impairment: Contributing environmental and genetic factors. Audiol Neurootol 2007;12:345-58.
2. Walling AD, Dickson GM. Hearing loss in older adults. Am Fam Physician 2012;85:1150-6.
3. Glyde H, Hickson L, Cameron S, Dillon H. Problems hearing in noise in older adults: A review of spatial processing disorder. Trends Amplif 2011;15:116-26.
4. Lee FS, Matthews LJ, Dubno JR, Mills JH. Longitudinal study of pure-tone thresholds in older persons. Ear Hear 2005;26:1-1.
5. Wiley TL, Cruickshanks KJ, Nondahl DM, Tweed TS. Aging and middle ear resonance. J Am Acad Audiol 1999;10:173-9.
6. Pacala JT, Yueh B. Hearing deficits in the older patient: I didn't notice anything. J Am Med Assoc 2012;307:1185-94.
7. Bielefeld EC, Tanaka C, Chen GD, Henderson D. Age-related hearing loss: Is it a preventable condition? Hear Res 2010;264:98-107.
8. Sogebi OA. Profile of ear diseases among elderly patients in Sagamu, South-Western Nigeria. Niger J Med 2013;22:143-7.
9. Feeney MP, Sanford CA. Age effects in the human mid-dle ear: Wideband acoustical measures. J Acoust Soc Am 2004;116:3546-58.
10. Uchida Y, Nomura H, Itoh A, Nakashima T, Ando F, Niino N, *et al.* The effects of age on hearing and middle ear function. J Epidemiol 2000;10:S26-32.
11. Wada H, Koike T, Kobayashi T. The effect of aging on middle ear dynamic characteristics. Nihon Jibiinkoka Gakkai Kaiho 1994;97:898-904.
12. Ruah CB, Schachern PA, Zelterman D, Paparella MM, Yoon TH. Age-related morphologic changes in the human tympanic mem-brane. A light and electron microscopic study. Arch Otolaryngol Head Neck Surg 1991;117:627-34.
13. Nondahl DM, Cruickshanks KJ, Wiley TL, Tweed TS, Dalton DS. 16-year change in acoustic admittance measures among older adults: Data from a population-based study. J Speech Lang Hear Res 2013;56:1745-50.
14. Doan DE, Erulkar JS, Saunders JC. Functional changes in the aging mouse

middle ear. Hear Res 1996;97:174-7.
15. Gaihede M, Koefoed-Nielsen B. Mechanics of the middle ear system: Age-related changes in viscoelastic properties. Audiol Neurootol 2000;5:53-8.
16. Golding M, Doyle K, Sindhusake D, Mitchell P, Newall P, Hart-ley D. Tympanometric and acoustic stapedius reflex measures in older adults: The blue mountains hearing study. J Am Acad Audiol 2007;18:391-403.
17. Cruz MS, Lima MC, Santos JL, Duarte YA, Lebrão ML, Ramos-Cerqueira AT. Self-reported hearing loss among elderly individuals in the city of São Paulo, Brazil: Prevalence and associated factors (SABE Study, 2006). Cad Saude Publica 2012;28:1479-92.
18. Mao Z, Zhao L, Pu L, Wang M, Zhang Q, He DZ, *et al*. How well can centenarians hear? PLoS One 2013;8:e65565.
19. Nixon JC, Glorig A, High WS. Changes in air and bone conduction thresholds as a function of age. J Laryngol Otol 1962;76:288-98.
20. Margolis RH. Detection of hearing impairment with the acoustic stapedius reflex. Ear Hear 1993;14:3-10.

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