

Comparison of Cognition between Elderly with Sensorineural Hearing Loss and Normal Hearing for Age

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ABSTRACT

Introduction

Age related hearing loss starts at mid to late adulthood. With ageing, cognitive ability also declines. The aims of this study were to assess, compare and correlate cognition of elderly people having bilateral moderate to profound sensorineural hearing loss with the population of normal hearing for age.

Methods

This observational analytical study included 25 elderly participants between 55 to 75 years of age in each group; Hearing loss Group with moderate to profound sensorineural hearing loss and Normal hearing Group with normal hearing. Based on pure tone audiometry, hearing loss was classified into moderate (41-60 dB), severe (61-80 dB) and profound (81 and above). Cognition status was assessed using a Nepali version of Mini-mental state examination and classified into no cognitive impairment, mild cognitive impairment and severe cognitive impairment. Comparison and correlation of the cognitive impairment was done between the groups.

Results

In Hearing loss Group, 8 (32%) participants and in Normal Hearing Group, 3 (12%) participants had mild cognitive impairment. Means of total Mini-mental state examination scores between the two groups had statistically significant difference ($p=0.02$) but no significant correlation (Kendall tau $b=0.20$) between age related hearing loss and cognitive impairment was found.

Conclusion

Though cognitive impairment was found more in participants with age related hearing loss, there was no correlation between age related hearing loss and cognitive impairment.

Keywords

Age-related hearing loss, cognitive impairment, mini-mental state examination

INTRODUCTION

Age-related hearing loss (ARHL) typically starts between 40 to 60 years of age. With age, 30–35% of adults between 65–75 years and 40–50% over 75 years suffer from ARHL.¹ ARHL accounted 10.09% of outpatient department visits in a study in Nepal.² As per WHO, there will be 1.2 billion persons of age more than 60, with more than 500 million having ARHL in the world by 2025.³

Cognition enables to tackle day-to-day activities by acquiring knowledge, understanding and performing various actions when needed. ARHL is a modifiable risk factor for cognitive impairment. Deprivation of quality auditory input in ARHL can lead to inability to understand and act in day-to-day life. Also, it has been seen to be associated with widespread neural degeneration and recruitment of other areas of brain to understand the low quality auditory input leaving behind lesser areas for cognitive function.^{4–7}

Mini-Mental State Examination (MMSE) is a cognitive function evaluation tool.⁸ Its cognitive screening sensitivity is 69% and specificity is 99% for cutoff score of 23 or less.⁹ It has been validated into various languages.^{10,11} Studies have shown that cognitive impairment is higher in elderly population with ARHL.^{1,11–14} A study even suggested that early management of ARHL may delay progression of cognitive impairment.¹⁵

Number of elderly people in Nepal is increasing. So, aim of this study was to compare the cognitive impairment between elderly people with moderate to profound SNHL and elderly people with normal hearing using mini mental status examination and see whether ARHL is associated with cognitive impairment or not.

METHODS

An observational analytical study was conducted in Department of ENT-Head and Neck Surgery, Institute of Medicine, Tribhuvan University, Kathmandu, Nepal from September 2020 to November 2021. Ethical approval was taken from the Institutional Review Committee of the Institute of Medicine. Convenient sampling was adopted and informed consent taken. Participants were between 55 to 75 years of age and were divided between two groups depending upon hearing status. Hearing loss Group participants had bilateral moderate to profound adult onset purely sensorineural hearing loss (SNHL) on both ears for at least 1 year duration. For the Normal Hearing Group, participants were age matched to Hearing loss Group who wanted their hearing to be assessed or spouse of Hearing loss Group participants who voluntarily underwent hearing assessment but had normal hearing. All the participants who had external and middle ear pathology for the hearing loss were excluded. Also, all those participants in both groups, whose

cognitive function would have been hampered by conditions like central nervous system disease, psychiatric illness, long-term use of sedatives, cerebral ischemia, head trauma, alcoholism were excluded. The sample size was calculated using formula:

$$\text{Sample size} = \frac{r+1}{r} \frac{(p) * (1-p) * (Z_{\beta} + Z_{\alpha/2})^2}{(p_1 - p_2)^2}$$

where,

- r = Ratio of control to cases = 1
- Z_{β} = 0.84
- $Z_{\alpha/2}$ = 1.96
- p_1 is proportion in Hearing loss Group = 30%¹
- p_2 is proportion in Normal Hearing Group = 70%
- p^* = Average proportion exposed = proportion of exposed cases + proportion of control exposed / 2 = $(p_1 + p_2) / 2 = (30\% + 70\%) / 2 = 0.5$

Hence, sample size = 25 in each group.

The pure tone audiometry test was performed on the same day of presentation to OPD. Pure-tone average (PTA) of hearing thresholds at 0.5–4 kHz was calculated for the better ear according to the American Academy of Otolaryngology-Head and Neck Surgery guidelines.¹⁶ The level of hearing impairment was calculated, as per classification stated by WHO, 1991.¹⁷

All the participants underwent interview based cognitive function assessment in the OPD following being divided into the two groups. For cognition assessment, Nepali version of MMSE was explained in simple terms and applied for evaluation in a quiet environment. The severity of cognitive impairment was classified into three categories depending upon the total score; score between 24–30 as no cognitive impairment; score between 18–23 as mild cognitive impairment; and score between 0–17 as severe cognitive impairment.

Data were analysed using SPSS statistical software version 26. Normality tests were applied for numerical data. Statistical tests applied were t-test, Mann Whitney U test, chi-square test, ordinal Kendall tau-b test wherever applicable. The p-value < 0.05 was considered to be statistically significant.

RESULTS

Each group comprised of 25 participants. The mean age was 65.3 ± 5.9 years in Hearing loss Group and mean age was 62.6 ± 5.6 years in Normal Hearing Group. The maximum number of patients were in the age group 55 to 65 years in both groups. Total number of participants were 7(28%) in the age group 55–60 years, 6(24%) in the 61–65 years age group, 4(16%) in the 66–70 years age group and 8(32%) in the 71–75 years age group in Hearing loss Group. Similarly, in Normal Hearing Group, the total number of participants were 11(44%) in the

Table 1. Comparison of no cognitive impairment between Hearing loss Group and Normal Hearing Group

Mini mental status examination component scores	Hearing loss Group(n=25) No cognitive impairment(n=17)	Normal Hearing Group(n=25) No cognitive impairment(n=22)	p-value
Orientation	10±0.0	9.9±0.3	0.21
Registration	2.8±0.5	3.0±0.0	0.12
Attention	4.1±0.9	4.5±0.9	0.28
Recall	2.2±0.9	2.5±0.5	0.10
Language	8.2±0.7	8.5±0.8	0.30
Total	27.5±1.6	28.5±2.1	0.12

**Independent samples t-test (not significant)

Table 2. Comparison of mild cognitive impairment between Hearing loss Group and Normal Hearing Group

Mini mental status examination component scores	Hearing loss Group(n=25) No cognitive impairment(n=8)	Normal Hearing Group(n=25) No cognitive impairment(n=3)	p-value
Orientation	9.6±0.5	9.0±1.0	0.19
Registration	2.5±0.5	2.7±0.6	0.67
Attention	1.8±0.7	2.0±1.0	0.65
Recall	1.3±0.7	1.7±0.6	0.39
Language	7.1±0.4	7.0±0.0	0.57
Total	22.2±0.9	22.3±1.2	0.90

**Independent samples t-test (not significant)

Table 3. Correlation of cognition in Hearing loss Group and Normal Hearing Group

Cognitive impairment	Hearing loss Group(n=25)	Normal Hearing Group(n=25)	p-value	Correlation***
None	17 (68%)	22 (88%)	0.98	0.20
Mild	8 (32%)	3 (12%)		
Total	22.2±0.9	22.3±1.2		

**Independent sample chi-square test (not significant)

***Ordinal by ordinal Kendall tau b correlation test (not significant)

55-60 years age group, 7(28%) in the 61-65 years age group, 4(16%) in the 66-70 years group and 3(12%) in the 71-75 years age group. In Hearing loss Group, there were a total of 23 males (92%) and 2 females (8%) with male to female ratio of 11.5:1. And, in Normal Hearing Group, there were 17 males (68%) and 8 females (32%) with 2.1:1 ratio. Median duration of hearing impairment in Hearing loss Group was 2.9 years. Maximum number of patients i.e., 9 patients had a duration of hearing impairment less than 2 years.

Out of 25 participants in Hearing loss Group, 17(68%) had moderate, 7(28%) had severe and only 1(4%) had profound hearing impairment. MMSE scores of the participants were calculated for each

domain. Mean total score of Hearing loss Group (25.8±2.9) was lesser than that of Normal Hearing Group (27.8±2.9) which was significant statistically (p-value=0.02).

Table 1 shows the mean scores of various domains and mean total of MMSE scores between participants with no cognitive impairment in the two groups and depicts no significant difference (p-value >0.05). Table 2 shows the mean scores of various domains and mean total of MMSE scores between participants with mild cognitive impairment in the two groups and depicts no significant difference (p-value >0.05).

No participants had severe cognitive impairment in both groups. Only 8(32%) participants in Hearing

loss Group had mild cognitive impairment and the rest 17(68%) participants had no cognitive impairment. Similarly, in Normal Hearing Group, 3(12%) participants had mild cognitive impairment and 22(88%) had no cognitive impairment. On applying chi-square test, this difference in number of participants with mild cognitive impairment in the groups was not statistically significant (p -value = 0.98). Also, using the Kendall tau b correlation test, no correlation was found between the two groups in terms of cognitive impairment as depicted in Table 3.

DISCUSSION

Since many studies have identified ARHL as a modifiable risk factor for cognitive impairment, if association is seen, early management of ARHL can be implemented to prevent impairment in cognitive abilities. Hence, this study, first of its kind in Nepal, was conducted to evaluate the association of ARHL with cognitive impairment in elderly population.

Male to female ratio of participants in this study were very high with male predominance in comparison to other studies.^{1,13} This might be due to patriarchal structure of Nepalese society, early health seeking behavior in males and higher number of male patients in OPD and convenience sampling. These also explain the median duration of hearing loss at time of presentation in Hearing loss Group being only 2.9 ± 2.8 years which is very low in contrast to other studies. The prospective matched case control study, each group containing 30 participants done by Huber et al.¹³, had highest mean duration of hearing loss of 21.3 ± 10.5 years. Despite such results, they found no significant correlation between duration of hearing loss and cognitive abilities.

Higher number of patients with lower degrees of hearing loss was seen in this study. The mean of the total MMSE score between Hearing loss Group and Normal hearing Group had statistically significant difference. Also, mean of total MMSE scores in participants with cognitive impairment and no cognitive impairment in each group had statistically significant differences. Such results were also observed in a retrospective review of 133 charts of individuals >50 years by Nirmalasari et al.¹⁸ This shows that individuals with ARHL can be expected to have lower MMSE scores than elderly with normal hearing. Also, mean scores demonstrated that Normal Hearing Group participants had performed better in assessment of registration, attention and recall domains. The mean scores of orientation and language were comparable with no significant difference between the two groups. This might be explained by the fact that all participants included in the study were literate individuals and

hence well oriented and better with language skills.

In Hearing loss Group, mean values of scores of the domains of cognition (orientation, attention, recall, language) and the mean of total MMSE scores were higher in participants with no cognitive impairment than those with mild cognitive impairment. The differences were statistically significant except for registration. This can be because assessment of registration involves repeating names of 3 random non-related objects and despite ARHL, lip reading might have been of help for the participants with cognitive impairment.

In Normal Hearing Group, mean values of scores of all domains of cognition including mean of total MMSE scores were more in participants with no impairment than participants with mild cognitive impairment as expected.

Mean scores of all domains and mean of total MMSE scores were compared between participants with no cognitive impairment in the two groups and no significant difference was found. Similar results were obtained in comparison of participants with mild cognitive impairment in the two groups. Assuming ARHL to be associated with cognitive impairment, the comparison of no cognitive impairment mean scores between the two groups should have yielded significant difference. But it was not so. It might be due to the fact that the maximum number of participants in Hearing loss Group had a duration of hearing loss for less than 2 years. Hence, no inference could be drawn.

No significant difference was seen in cognitive impairment between the two groups. Likewise, no significant correlation between ARHL and cognitive impairment was noted which is against the results of previous related studies.¹¹⁻¹⁴

The limitations of the study were lesser number of participants, lesser duration of hearing loss, cross-sectional hospital-based study which might not properly represent the general population and maximum number of participants in Hearing loss Group had only moderate degree of hearing loss.

CONCLUSION

Mild type of cognitive impairment was seen more in elderly people with bilateral moderate to profound sensorineural hearing loss compared to those with normal hearing for age. No significant correlation was seen between ARHL and cognitive impairment.

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CONFLICT OF INTEREST

The author(s) declare that they do not have any conflicts of interest with respect to the research, authorship, and/or publication of this article.

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