

Presbycusis and hyperlipidemia: Is there any link?Refad Abdul Azeez¹, Ahmed Al Ansary^{2*}, Thenoon Yasin²**Abstract**

Age related hearing loss is one of the most common chronic health conditions affecting the elderly people. With aging, risk of Presbycusis and hyperlipidemia increases. Although most studies do reach some sort of agreement, the evidence supporting a relationship between presbycusis and hyperlipidemia remains questionable. The objective of this study is to determine the association between age related hearing loss and hyperlipidemia and assess the severity of hearing loss in hyperlipidemic patients. This cross sectional analytic study was carried out at ENT Out Patient Clinic at Al Sader teaching Hospital from March 2019 to December 2019. A cross-sectional study on 52 patients with Hyperlipidemia and 42 non Hyperlipidemic patients was carried out during March 2019 to December 2019. All patients were evaluated for hearing loss by subjecting to pure tone audiometry, blood investigations were done in form of lipid profile, blood sugars, thyroid function test, blood urea and serum creatinine levels. Group A consisted of 22 (42.3%) males and 30 (57.7%) female while group B consisted of 23 (54.8%) male and 19 (45.2%) female individuals. Audiological assessment by PTA was show that the prevalence of presbycusis among hyperlipidemic group more than non hyperlipidemic with significant statistical difference (P value <0.05). Prevalence was 76.9%. In conclusion; there is statistically significant association between presbycusis and hyperlipidemia especially those with hypercholesterolemia.

Key words: Hyperlipidemia; Hearing loss; Age

* Correspondence author: aalansary@yahoo.com

¹Al Sader Teaching Hospital/ Basrah, Iraq

²Basrah Teaching Hospital/ Basrah, Iraq

Received 11 September 2020, Accepted 02 November 2020, Available online 15 December 2020

This is article permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Introduction

Hearing is one of the most essential senses to human; it acts as a communication tool with the external environment and particularly his or her family. Hearing like other body functions affected with aging by different mechanisms [1]. Hearing loss can be an important factor that donates to isolation, depression, and possibly dementia in the elderly [2]. Presbycusis is defined as bilateral, progressive, symmetrical sensorineural hearing loss (SNHL), mid to late-age onset after exclusion of other causes of hearing loss, characterized by a high

frequency SNHL with deficits in speech discrimination [3, 4]. Hyperlipidemia is believed to cause an auditory dysfunction by increasing blood viscosity, vascular occlusion [2, 5]. Many factors that are associated with the development of Presbycusis like noise exposure, cigarette smoking, alcohol consumption, hypertension, blood hyperviscosity and cardiovascular diseases [2]. Schuknecht developed a classification system that highlights the cochlear changes that have been noted in association with age-related hearing [4].

- Sensory

Epithelial atrophy with loss of sensory cells and the supporting cells of the organ of Corti. Progressive hair cell reduction begins at about age of forty [3].

- Neural

Reduction in the total number of functioning cochlear neurons. Of the 35,500 cochlea neurons at birth, Schuknecht has estimated that 2,100 neurons are lost each decade. When reduction has reached 50% or more of the normal neuronal population, hearing loss develops [4].

- Strial or metabolic

Atrophy of the stria vascularis, which normally maintains the chemical and bioelectric balance and metabolic health of the cochlea [3].

- Mechanical or cochlear conductive

This condition results from thickening and secondary stiffening of the basilar membrane of the cochlea. The thickening is more severe in the basal turn of the cochlea where the basilar membrane is narrow [4].

- Intermediate

Due to Possible changes in intracellular organelles involved in cell metabolism, decrease in synapse numbers and changes in endolymph composition [6].

- Mixed A combination of the other five subtype [3].

Patients and methods

A cross sectional analytic study carried out from March 2019 to December 2019 on a sample of patients (112) aged 50 years and above whom attended ENT and Medical Departments at Al Sader Teaching Hospital. The study was designed to compare between prevalence of presbycusis among hyperlipidemic patients and those without hyperlipidemia. Ethical consideration was approval from Arabic Board of medical specialty acquired for this study. Verbal consent was taken from each participant. Only 94 patients enrolled in this study (45 males and 49 females), 52 hyperlipidemic and 42 non-hyperlipidemic patients according to laboratory findings without any other comorbidities and 18 patients were excluded from our study for the following reasons history of Diabetes [5], hypothyroidism [2], drug use e.g.

aminoglycoside drugs [4], chronic discharging ear or ear surgery [3], excessive or chronic noise exposure [3] and head trauma [1].

We included newly diagnosed hyperlipidemic patients aged 50 years and above with and without hearing loss and non-hyperlipidemic members who were age and sex matched without any comorbidities. Data were collected by the researcher through direct face to face interview. A detailed history and clinical examination were performed and the results recorded on a pre-designed questionnaire.

Investigations were done for each patient as a part of general assessment; the results were picked up from the laboratory save system (LS system) computers in the following form: Lipid profile, blood urea, serum creatinine, thyroid function test and blood sugar (fasting and/or post prandial). Full otological assessment done for each participant including Tuning fork tests to take a preliminary idea about the hearing status.

All participants were sent for pure tone audiometry which done by using the Interacoustics AD226 Audio Traveller Audiometer. Data was coded and analyzed by using Microsoft excel and SPSS program (Statistical package for the Social Sciences) version 23. Risk and odd's ratio (is a measure of strength of association between an exposure and an outcome) calculated. Significance was tested when possible using Chi squared and Fisher's exact test. P- Value less than 0.05 considered significant.

Results

This is a cross sectional analytic study involving 52 hyperlipidemic (Group A) and 42 non hyperlipidemic (Group B) subjects. Group A consisted of 22 (42.3%) males and 30 (57.7%) female while the group B consisted of 23 (54.8%) male and 19 (45.2%) female individuals. The majority of studied patients belong to age group 60-69 year in both groups with a frequency of 25 members for group A and 16 members for group B respectively. Table 1 shows age related hearing loss (ARHL) was more frequently present among group A (hyperlipidemic group) in percentage of 76.9% with significant statistical difference (P value <0.05). The odds ratio (4.44) indicates that the risk is approximately 4 folds higher in hyperlipidemic as compared to non hyperlipidemic subjects.

Table 1.

Hearing loss according to PTA

Hearing loss	Group A		Group B		Total	
	Frequency	%	Frequency	%	Frequency	%
Absent	12	23.1	24	57.1	36	38
Present	40	76.9	18	42.9	58	62
Total	52	100	42	100	94	100

P value 0.001

Odds ratio 4.44

Table 2 shows that 57% of members among group B are within the normal hearing range while in group A only 23% have normal hearing level. 57% of members among group B are within the normal hearing range while in group A only 23% have normal hearing level. The members of group A have severe hearing loss in a percentage of (26.9%) followed by moderate H.L (21.2%) while those in group B moderate and moderately severe H.L of same percentage (7.1%) with no one has profound H.L in contrast to group A who have profound H.L (5.8%) with significant statistical difference (p value 0.001).

Table 2.

Hearing level of studied population

Hearing level	Group A		Group B		Total	
	Frequency	%	Frequency	%	Frequency	%
Normal hearing	12	23%	24	57.1%	36	38.2%
Mild hearing loss (26–40 dB)	5	9.6%	10	23.8%	15	15.9%
Moderate hearing loss (41-55 dB)	11	21.2%	3	7.1%	14	14.9%
Moderately severe hearing loss (56-70 dB)	7	13.4%	3	7.1%	10	10.6%
Severe hearing loss (71-90dB)	14	26.9%	2	4.7%	16	17.0%
Profound hearing loss (>90dB)	3	5.8%	0	0.0%	3	3.2%
Total	52	100.0%	42	100.0%	94	100.0%

Table 3 shows that cholesterol, triglycerides and low density lipoprotein are significantly higher in hyperlipidemic patients as compared to non hyperlipidemic individuals (P value <0.05). High density lipoprotein did not show significant statistical difference between the two groups (P value>0.05).

Table 3.

Lipid profile in both groups

Lipid profile		Group A (N=52)	Group B (N=42)	P value*
Cholesterol	Mean ± SD	230.5 ± 42.8	152.6 ± 35.8	0.0001
	Median	228.7	157.3	
TG	Mean ± SD	220.0 ± 80.7	115.35 ± 32.4	0.0001
	Median	210.7	121.4	
LDL	Mean ± SD	147.6 ± 46.6	98.5	0.0001
	Median	154.7	103.4	
HDL	Mean ± SD	43.57 ± 14.6	41.1 ± 13.8	0.749
	Median	41.2	41.3	

In table 4 odds ratio for each individual lipid was calculated. Considering the high lipids (and low HDL) as risk exposure. Odds ratio of total cholesterol is the highest obtained among other lipids and according to its confidence interval, it is significantly high to consider that exposed patients are at increased risk by two folds as compared to those with low exposure.

Table 4.

Lipid profile * PTA findings in Hyperlipidemic group cross tabulations (odds ratio)

		PTA :no SNHL (N = 12)	PTA :SNHL (N = 40)	P value *	Odds ratio (C.I)
Total cholesterol	Normal (N %)	1 (8.3%)	7 (17.5%)	0.440	2.3 (2.1-3.9)
	High (N %)	11 (91.7%)	33 (82.5%)		
TG	Normal (N %)	2 (16.7%)	8 (20.0%)	0.797	0.8 (0.2-4.3)
	High (N %)	10 (83.3%)	32 (80.0%)		
LDL	Normal (N %)	6 (50%)	16 (40%)	0.539	1.5 (0.5-2.1)
	High (N %)	6 (50%)	24 (60%)		
HDL	Normal (N %)	7 (58.3%)	21 (52.5%)	0.722	1.3 (0.3-4.6)
	Low (N %)	5 (41.7%)	19 (47.5%)		

Discussion

Presbycusis has a major impact on the quality of human life, and is related to a reduce communication skills, social isolation and possibly exacerbating anxiety-depressive status [7]. The degenerative processes of presbycusis are probably influenced by many factors such as heredity, environmental and systemic comorbidities such as hyperlipidemia, many studies tried to evaluate this relationship, but it is still subject to question [8]. In this study we are trying to clarify this controversy.

Multiple limitations we faced during conducting this study which are:

1. Presbycusis is slowly progressive disease and it's often undetected for several years. The exact duration of disease onset is difficult to determine.
2. The elderly find it difficult to visit the out patients clinic when they feel a difficulty in hearing without help of another person for communication and most of them are unable to retrieve their medical history as a result of poor memory.
3. Most of hyperlipidemic patients are smokers, have other diseases or exposed to noise in their jobs and all of them should be excluded from this study.
4. High frequencies above 8000 Hz cannot be assessed by conventional audiometer and high frequency audiometer not available.

The mean age of the studied population is 63.27 year for hyperlipidemic group and 64.9 year for non hyperlipidemic group. This is calculated after excluding the patients below 50 years and those caused by other comorbidities like diabetes, hypertension, renal failure and cardiovascular disease. This result is well matched with the study of Ming Zhang et al [9] who found that the mean age of studied population was 65 years. Many authors [10,11] believed that the regular use of some anti hyperlipidemic drugs improve hearing loss in hyperlipidemic patients with presbycusis so we excluded those patients from our study to avoid bias result due to above mentioned causes. No statistically significant difference was found between both groups in terms of age and the most affected age group was at seventh decade while the least one at ninth decade (table3.1), This result is similar to the study of Parmar et al [12], while disagree with the findings [13, 14] they found a significant relationship with age and mentioned that older age are associated with poorer auditory function and most affected age group was at sixth decade.

The probable explanations for our finding that most advanced age patients are disabled or neglected and rarely visit Out Patient Clinic about their hearing problems without a companion, no well fear amenities and poor education about the impact of hearing loss. In the present study, we found that number of males were (45) and females (49). Male to female ratio was 1.09:1, but no statistical significant relationship between the age related hearing loss and the sex distribution of the studied patients. This was not matching with the

finding of Lee et al [15] and Jain et al. [16] they found that males have higher chances of hearing loss than females and explain the finding by that males tend to work more in noisy environment in comparison to females due to which they have higher chances of hearing loss.

Our findings may be explained by multiple military events that happened during nineteenth century in Iraq that leads to decrease the number of males in relation to females, probably due to difference in the study settings and numbers of patients included in this study and because their societies are industrial and we are more agricultural societies. We found that (51.9%) were living in urban areas while (48.1%) lived in rural. There is no statistical significant relationship between the risk of occurrence of presbycusis and the residency and this may be due to improvement in transport facilities nowadays that enable people in rural areas to seeking medical care.

The present study shows a significant relationship between Presbycusis and hyperlipidemia. Audiometric evaluations show that the prevalence of presbycusis in hyperlipidemic group (76.9%) more than non hyperlipidemic group (42.9%) with significant statistical difference (P Value <0.05). The odds ratio indicates that the risk is approximately 4 folds higher in group A as compared to group B subjects. These findings are consistent with report of Evan et al (16) they found that elevated serum lipid especially triglyceride levels were associated with increased hearing loss, and Simpson et al. [17] who found that hyperlipidemia be significantly associated with auditory dysfunction in elderly patients, but disagree with the studies of Friedrich and Pilger (18) whom found no change in serum triglyceride or cholesterol concentrations in elderly patients with sensorineural hearing loss. Gates et al. [19] similarly reported no correlation of hearing level with cholesterol or triglyceride and lee et al [15] in a cross- sectional study reported no significant association between pure-tone thresholds and TC, LDL, and HDL.

The present study findings can be explained by these mechanisms:

- a) Lipid deposition (lipidosis) of the membranous inner ear [20].
- b) Inner ear is an end organ and the blood supply of stria vascularis and hair cells is highly susceptible to vascular events. Hyperlipidemia leads to deposition of lipids in end arteries, thereby causing narrowing, resulting in compromised blood supply causing chronic hypoxia that disturbs cochlear metabolism [21].
- c) Histopathological studies have shown damage to the nerves and vessels of the inner ear of the individuals with hyperlipidemia, which have been theorized to be an important causative factor for neuronal degeneration in the auditory system [5].
- d) Cholesterol is an essential component of cellular membranes because it stabilizes them and modulates lipid and protein transport across the membrane, increased uptake of

cholesterol by hair cells increases their stiffness which impairs the electro motile response of hair cells and the cochlear amplifier [22].

The present study showed that hyperlipidemic group (group A) shows high percentage of severe hearing loss (26.9 %) as compared with non hyperlipidemic group (group B) (4.7%) with significant statistical differences (table 2). This finding well matched with the results of Odeh et al [5] who found that the sever hearing loss in hyperlipidemic patients is 45% and disagree with the finding of Cadoni et al [23] who found that the percentage of sever hearing loss is (16.4%), this difference between our findings and them may be due to sample size, duration of hyperlipidemia or delay in complaining from age related hearing loss.

The result of our study shows that the most prevalent type of hyperlipidemia was hypercholesterolemia and those patient have a two folds' risk of presbycusis than those with other type of hyperlipidemia (odds ratio 2.3) as seen in (table 4) this agree with the studies of Yucel, Hilal et al [10] and Gopinath, Bamini et al [11] they found that high dietary intake of cholesterol was associated with an increased likelihood of sensorineural hearing loss. Keles et al [7] compared serum level of metabolic presbycusis patients and control group and reported that total cholesterol was found to be statistically significantly high in those with presbycusis. Our findings disagree with Jones and Davis [24] who found that the study of 85 patients with sensorineural hearing loss showed no significant difference between their cholesterol level and that of the control group.

Conclusions and Recommendations

From the current study it can be concluded that there is a significant link between Presbycusis and hyperlipidaemia so it can be considered as risk factors for its occurrence. Hypercholesteremic patient is more liable to presbycusis than those with other types of hyperlipidemia. Hearing screening programs for elderly hyperlipidemic patients with the use of high frequency pure tone audiometry, speech audiometry and ABR are recommended on regular interval for early detection and assessment of presbycusis to prevent its secondary impacts. More studies with a long duration and a larger sample size in addition to postmortem histopathological study are needed for fully understand the exact relationship between Presbycusis and hyperlipidemia with emphasis on hypercholesterolemia. Further studies are required to know the role of antihyperlipidemic drugs in the management of presbycusis.

Ethical Approval

The study was approved by the Ethical Committee.

Conflicts of Interest

The authors declare that they have no competing interests.

References

1. Robert T. Sataloff MMJ and Karen M. Kost. Age-Related Hearing Loss In: Kourosh Parham FRL, and Brian W. Blakley (eds). *Geriatric Otolaryngology*: New York; 2015. p. 40-62.
2. Swaminathan AR, Sambandam, Bhaskaran M. Evaluation of the auditory effects of hyperlipidaemia and diabetes mellitus by using audiometry. *J Clin Diagn Res* 5 2011:1528-32.
3. Linnea Cheung D. Age related hearing loss. In: John C Watkinson and Raymond W Clarke(ed.). *Scott-Brown's otorhinolaryngology and head and neck surgery*. Volume2. 8th ed . Boca Raton : CRC Press Taylor and Francies group; 2018. p. 639- 700.
4. Selena E Heman-Ackah SKJ. Presbycusis. In: Robert T Sataloff, editor. *Sataloff's Comprehensive Textbook of Otolaryngology: Head and Neck Surgery: Otology/Neurotology/Skull Base Surgery volume*
5. Odeh OI, Kuti MA, Fasunla AJ, Nwaorgu OG. Sensorineural hearing loss and dyslipidemia: is there any relationship. *West Afr J Med* 2015;34: 27-31.
6. Arvin B, Prepageran N, Raman R. High Frequency Presbycusis—Is There an Earlier Onset?. *Indian Journal of Otolaryngology and Head & Neck Surgery* 2013; 65(3):480-484.
7. Keleş E, Kapusuz Z, Gürsu MF, et al. The relationship between metabolic presbycusis and serum paraoxonase/arylesterase activity. 2014;66(1):147-52.
8. Kearns J R. Presbycusis." *Canadian Family Physician* 1977;23: 96.
9. Zhang M, Gomaa N, Ho AJJoO, Head, Surgery N. Presbycusis: a critical issue in our community. 2013;2(04):111.
10. Gregg LN, Ford L, Gerstein E. Diabetes and depression in atherosclerosis individuals at high cardiovascular risk. *American Journal of BioMedicine* 2016;4(1):93-109.
11. Gopinath B, Flood VM, Teber E, McMahon CM, Mitchell P. Dietary intake of cholesterol is positively associated and use of cholesterol-lowering medication is negatively associated with prevalent age-related hearing loss. *The Journal of nutrition*. 2011; 141(7):1355-1361.
12. Parmar SM, Khare P, Chaudhary MJJo O. Evaluation of effects of diabetes mellitus type 2 and hyperlipidemia on hearing. 2017;23(3):155.
13. Ciorba A, Bianchini C, Pelucchi S, Pastore AJCiia. The impact of hearing loss on the quality of life of elderly adults. 2012;7:159.
14. Austin EW, Ao L, Cleveland JC, Fullerton DA, Meng X. Ghrelin reduces myocardial injury following global ischemia and reperfusion via suppression of myocardial inflammatory response. *American Journal of BioMedicine* 2014;2(1):26-36.
15. Lee FS, Matthews LJ, Mills JH, Dubno JR, Adkins WY. Analysis of blood chemistry and hearing levels in a sample of older persons. *Ear Hear* 1998; 19: 180– 190.
16. Jain A, Thomas J. Impact of hearing loss in the lives of geriatric individuals. *Int Otorhinolaryngology Head Neck Surgery* 2019;5:1207-12.

17. Simpson AN, Matthews LJ, Dubno JR. Lipid and C-reactive protein levels as risk factors for hearing loss in older adults. *Otolaryngology--Head and Neck Surgery* 2013;148(4):664-670.
18. Friedrich G, Pilger EJAoo-r-l. Lipoproteins in cochleovestibular disorders (author's transl). 1981;232(2):101-5.
19. Gates GA, Cobb JL, D'Agostino RB, Wolf PAJAoOH, Surgery N. The relation of hearing in the elderly to the presence of cardiovascular disease and cardiovascular risk factors. 1993;119(2):156-61.
20. Hashisaki GT. Sudden Sensory HearingLoss. In: *Head & Neck Surgery –Otolaryngology*. 4th ed. Bailey, ByronJ; Johnson, Jonas T; Newlands SD,editor. Lippincott Williams & Wilkins;2006. p. 2231– 6.cited in Odeh, O. I.2015.
21. Deepika P, Rajeshwary A, Usha S, Goutham MK, Raghav S. Does dyslipidemia worsen the hearing level in diabetics?. *Journal of otology*. 2017; 12(4):198-201.
22. Nguyen TVN, Brownell WE. Contribution of membrane cholesterol to outer hair cell lateral wall stiffness. *Otolaryngology-Head and Neck Surgery*. 1998; 119(1):14-20.
23. Cadoni G, Scorpecci A, Cianfrone F, et al. Serum fatty acids and cardiovascular risk case-control study. *Factors Annals in of sudden sensorineural hearing loss: Otology,Rhinology&Laryngology*, 2013;119(2), 82-88.
24. Jones NS, Davis A. A prospective case-controlled study of patients presenting with idiopathic sensorineural hearing loss to examine the relationship between hyperlipidaemia and sensorineural hearing loss 1. *Clinical Otolaryngology & Allied Sciences* 1999;24(6):531-536.