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ScienceDirect

Journal of Otology 12 (2017) 198–201

www.journals.elsevier.com/journal-of-otology/

Does dyslipidemia worsen the hearing level in diabetics?

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Received 14 June 2017; revised 18 July 2017; accepted 20 July 2017

Abstract

Objective: To identify the effect of dyslipidemia on auditory function detected by Pure Tone Audiometry. To check if dyslipidemia worsens the hearing level in diabetics.

Design: This was a comparative study where 120 subjects between the age group of 20 and 50 years underwent pure tone audiometry, lipid profile and blood sugars. Group 1 consisted of 30 subjects with type 2 diabetes and dyslipidemia; Group 2 had 30 subjects with isolated diabetes; Group 3 had 30 with isolated dyslipidemia and Group 4 included 30 normal subjects as control.

Results: Significant hearing loss was seen only in the group with isolated diabetes (63%). The most common type of hearing loss was high frequency sensorineural hearing loss. When comparison was made between the combinations of different lipid profiles, no association was found to the level of hearing.

Conclusions: Diabetics are more prone to high frequency hearing loss. Altered lipid profile has no role in causing hearing loss.

Keywords: Dyslipidemia; Diabetes; Pure tone audiometry

1. Introduction

Dyslipidemia is known to cause multi-organ dysfunction. High serum levels of Low Density Lipoprotein (LDL) and low levels of High Density Lipoprotein (HDL) are found to be associated with coronary heart disease. Low Density Lipoproteins facilitate the formation of atherosclerotic plaque. Oxidised LDL leads to endothelial dysfunction which increases the expression of adhesion molecules. High Density Lipoprotein when low is a strong risk factor for atherosclerosis (Rader & Puré, 2005;Badimon & Vilahur, 2012).

The role of dyslipidemia in sensorineural hearing loss is limited and contradictory. No human studies have proven the role of dyslipidemia in causing hearing loss. Animal studies have shown that hypercholesterolaemia causes oedema of the stria vascularis and outer hair cells, which in turn causes auditory disturbances (Satar et al., 2001). Chronic hypercholesterolaemia metabolically stresses inner ear tissue (Gratton & Wright, 1992). The cochlea, whose blood supply comes from an end artery, is considered to be highly sensitive to vascular changes. It is well known that high cholesterol level leads to arteriosclerotic changes in vessel walls and narrowing of the lumen. This in turn causes end organ hypoxia. Ischaemic damage of cochlea causes structural and functional disturbances (Nomiya et al., 2008). Other hypotheses include microthrombosis and hyperviscosity of cochlear

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Peer review under responsibility of PLA General Hospital Department of Otolaryngology Head and Neck Surgery.

http://dx.doi.org/10.1016/j.joto.2017.07.003

1672-2930/

vessels leading to hearing loss (Belal, 1979). Increased uptake of cholesterol by hair cells increases their stiffness which impairs the eletromotile response of hair cells (Nguyen, 1998). Diabetes is known to cause hearing loss by means of microangiopathy of the inner ear. It also causes degeneration of the stria vascularis and cochlear outer hair cells (Fukushima et al., 2006). The combined effect of diabetes and dyslipidemia can thus worsen the hearing loss. The purpose of this study was to know the role of dyslipidemia is hearing loss as there is a growing population of people with altered lipid profile in recent years.

2. Materials and methods

This was a comparative study done in a tertiary care hospital from January 2016 to March 2017, where 120 subjects between the age group of 20 and 50 years with normal intact tympanic membrane were analysed. As advanced age is known to cause hearing loss, the study group was limited to people less than 50 years. Ethical clearance was obtained from the institutional ethical committee prior to the study. The study group consisted of 30 subjects with type 2 diabetes and dyslipidemia (Group 1); 30 with isolated diabetes (Group 2); 30 with isolated dyslipidemia (Group 3) and 30 normal subjects as control (Group 4). All were subjected to lipid profile, blood sugars and pure tone audiometry. The level of hearing in these subjects were analysed and comparison made between them. A correlation was made between the different lipid profile abnormalities and hearing level. Pure Tone Audiometry was performed to measure air and bone conduction by using a Pure Tone Audiometer, model GSI GrasonStadler 61. Patients with history of ear discharge, ear surgery, head injury, ingestion of ototoxic drugs like aminoglycosides; smoking, alcohol; chronic systemic diseases; and long term exposure to noise were excluded.

Patients were diagnosed as diabetics if they had fasting blood glucose more than 126 mg/dL ($\geq$7 mmol/L) and/or 2-hr post prandial-glucose more than 200 mg/dL ($\geq$12.2 mmol/L) (WHO, 2006). The patients were said to have dyslipidemia if the blood cholesterol level was more than 200 mg/dL, Low Density Lipoprotein (LDL) level was more 100 mg/dL, Triglyceride level was more than 150 mg/dl and if the HDL level was less than 40 mg/dL (NCEP, 2001).

Hearing loss was graded according to the American Speech Language Hearing Association guidelines. Mild hearing loss was 26–40 dB, Moderate 41–55 dB, Moderately severe 56–70 dB, Severe 71–90 dB, Profound 91+ dB.Frequencies less than 1 kHz was considered as low frequency, 1–2 kHz was mid frequency, and above 2 kHz was high frequency (Clark, 1981).

The data thus collected was entered into a spreadsheet and analysed by using the SPSS software. Descriptive tables were generated. Chi square test, ANOVA statistical techniques and binary logistic regression were used to demonstrate the findings. A p value of less than 0.02 was considered to be statistically significant.

Table 1
Hearing level in the different groups.

Groups	Hearing loss		p Value
	Yes (N = 49)	No (N = 71)	
DM + dyslipidemia	15 (50%)	15 (50%)	0.032
Diabetes	19 (63.3%)	11 (36.7%)	0.002*
Dyslipidemia	8 (26.7%)	22 (73.3%)	0.766
Control	7 (23.3%)	23 (76.7%)	

*Statistically significant.
Gp 1 − p value: 0.032, Alpha = 0.05/3 = 0.017 ~ 0.02.
Gp 2 − p value: 0.002*.
Gp 3 − p value − 0.766.

3. Result

The sample included 50 females and 70 males between the age group of 20–50 years (Mean age of 43 years).

In group 1, the average duration of diabetes was 4.9 years. Twenty six out of 30 patients were on treatment for diabetes. The average glycosylated haemoglobin was 8.7 gm%. Twenty six out of 30 patients were newly detected to have dyslipidemia. Out of 4 previously diagnosed dyslipidemic patients, only 2 were on treatment for the same. The average total cholesterol was 226 mg/dL, HDL was 36 mg/dL, LDL was 143 mg/dL, VLDL was 46.5 mg/dL, and triglyceride was 224.5 mg/dL. The average hearing level was 19 dB. Of the 15 patients with hearing loss, 9 had high frequency hearing loss.

In group 2, the average duration of diabetes was 5.7 years. Twenty nine out of 30 were on regular medication for diabetes. The average glycosylated haemoglobin was 8.4 gm%. The average hearing level was 23 dB. Hearing loss was seen in 19 patients. Low frequency hearing loss was seen in 1 patient, mid frequency in 3, high frequency in 7, Mid & high frequency in 4 and all frequencies in 4 patients.

In group 3, the average duration of dyslipidemia was 7.2 months. Seven out of 30 were on treatment for dyslipidemia. The average total cholesterol was 231 mg/dL, HDL was 37.4 mg/dL, LDL was 145.6 mg/dL, VLDL was 40.9 mg/dL and triglyceride was 207.4 mg/dL. The average hearing level was 17 dB. High frequency hearing loss was seen in 6 patients and 2 had all frequencies involved.

In the control group, 7 had hearing loss. The average hearing level was 16 dB. Out of the seven, 5 had high frequency hearing loss.

The hearing level in different groups is shown in Table 1. In group 1 (Diabetes + dyslipidemia), 15 (50%) had hearing loss with p value of 0.032; in group 2, (Isolated diabetes) 19 (63%) had hearing loss with p value of 0.002; in group 3 (Isolated dyslipidemia), 8 (27%) had hearing loss with a p value of 0.766; and in group 4 (Controls), 7(23%) had hearing loss. The p value in group 2 was statistically significant.

The most common type of hearing loss was high frequency sensorineural hearing loss, as shown in Table 2.

Table 3 compares the effect of each lipid fraction to the hearing level. Binary logistic regression was done. No statistical significance was seen between the lipid fractions. When comparison was made between the combinations of

Table 2
Type of hearing loss.

Groups	Hearing loss	Low frequency	Mid frequency	High frequency	Mid + high frequency	All frequencies
Diabetes + dyslipidemia	15		2	9	4	
Diabetes	19	1	3	7	4	4
Dyslipidemia	8			6		2
Controls	7			5	1	1

Table 3
Effect of individual lipid fraction on the level of hearing.

		Hearing Loss		Unadjusted OR (95% CI)	Adjusted OR (95% CI)	p Value
		Yes (N = 49)	No (N = 71)			
TC	Abnormal	16 (37.20%)	27 (62.80%)	0.79 (0.37, 1.70)	0.90 (0.26, 3.14)	0.872
	Normal	33 (42.90%)	44 (57.10%)	1		
HDL	Abnormal	8 (44.40%)	10 (55.60%)	1.19 (0.43, 3.27)	1.31 (0.43, 4.00)	0.636
	Normal	41 (40.20%)	61 (59.80%)	1		
LDL	Abnormal	26 (35.60%)	47 (64.40%)	0.58 (0.28, 1.22)	0.53 (0.20, 1.35)	0.182
	Normal	23 (48.90%)	24 (51.10%)	1		
VLDL	Abnormal	22 (45.80%)	26 (54.20%)	1.41 (0.68, 2.96)	1.98 (0.55, 7.18)	0.797
	Normal	27 (37.50%)	45 (62.50%)	1		
TG	Abnormal	23 (43.40%)	30 (56.60%)	1.20 (0.58, 2.52)	0.73 (0.16, 3.26)	0.68
	Normal	26 (38.80%)	41 (61.20%)	1		
Diabetics	Abnormal	34 (56.70%)	26 (43.30%)	3.92 (1.80, 8.52)	4.21 (1.88, 9.49)*	0.001
	Normal	15 (25.00%)	45 (75.00%)	1		

different lipid profiles, no association was found to the level of hearing.

4. Discussion

Almost 2/3rd of diabetics have some degree of hearing loss (Bainbridge et al., 2008). A relationship between diabetes mellitus and hearing loss has been found in many clinical investigations (Aladag et al., 2009; Cullen & Cinnamond, 1993). But the role of dyslipidemia in causing hearing loss is controversial.

Cochlear vessels are end arteries and almost devoid of anastomoses. It is thus vulnerable to reduced blood flow and hypoxia, which gradually occurs in arteriosclerosis (Wright, 1997). The autoregulation in cochlea is weaker compared to the brain, (Yamamoto et al., 1991). Hypercholesterolaemia is known to cause atherosclerotic change in the vessel wall. When hypoperfusion of cochlear tissue occurs, there is release of free radicals which in turn affects the auditory neuro-epithelia (Seidman et al., 2002). In hypercholesterolaemia the platelets become more sensitive to epinephrine, which leads to thrombosis (Carvalho et al., 1974). It is proposed that these arteriosclerotic changes in cochlear vessels may lead to hearing loss.

Nomiya et al. studied cadaveric temporal bones of young individuals with arteriosclerosis and found a significantly lower number of spiral ganglion cells in the cochlea with generalized arteriosclerosis. Loss of outer hair cells, atrophic stria vascularis and spiral ligament was noted in the basal turn in temporal bones with generalized arteriosclerosis as compared to controls (Nomiya et al., 2008). Temporal bone studies done in diabetic individuals have shown similar results (Fukushima et al., 2006).

Studies have shown that chronic dyslipidemia may reduce auditory function, but short-term dietary changes may not (Evans et al., 2006). The largest study done by Suzuki et al., where 924 individuals were studied, found a low level of high-density lipoprotein (HDL) concentration was associated with hearing loss (Suzuki et al., 2000).

The association of hearing loss and lipid profile has also been studied by analysing genetic conditions with cholesterol homeostasis dysregulation. Conditions affecting cholesterol intracellular transport and synthesis like Smith-Lemli-Opitz syndrome and Niemann—Pick disease have been found to be associated with sensorineural hearing loss (Berardino et al., 2007; King et al., 2014).

Our study showed a significant association between diabetes and hearing loss. The most common type of hearing loss we observed was high frequency sensorineural hearing loss. There was no significant hearing loss in patients with isolated dyslipidemia and patients with both diabetes and dyslipidemia, as compared to isolated diabetes. A similar study was done by Swaminathan et al. (2011). In contrast to our study, they observed a significant hearing loss in patients with isolated dyslipidemia and patients with both diabetes and dyslipidemia (Swaminathan et al., 2011). The hearing loss was a mild to moderate, progressive, bilateral, sensorineural type of gradual onset which affected predominantly the higher frequencies. They found that high total cholesterol, high triglycerides and high LDL levels were associated with hearing loss. We too found bilateral, symmetric, high frequency hearing loss in diabetics. When the individual and combination of the different lipid profiles were considered, no significant hearing loss was found in our study.

Though one would expect a synergistic action of diabetes and dyslipidemia on the hearing level, it was not so in our study. The combination of different lipid profiles had no significance either. It can thus be concluded that dyslipidemia has no role in causing hearing loss.

Limitations of the study – Diabetes and dyslipidemia are often undetected for several years. The exact duration of disease onset is difficult to determine. Further studies with increased sample size are recommended.

5. Conclusion

Diabetics are more prone to high frequency hearing loss. Altered lipid profile has no role in causing hearing loss. Further studies with a larger sample size are required in this field.

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