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Main Article

Hypertensive retinopathy and sensorineural hearing loss

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Abstract

Objective To determine the correlation between hypertensive retinopathy (which is the end-organ damage of the vessels due to chronic hypertension) with sensorineural hearing loss.

Methods Pure tone hearing threshold of 56 hypertensive patients were compared with 56 normal age and sex matched control. Comparisons of pure tone hearing threshold are made among different group (grade) of hypertensive retinopathy patients and control (non-hypertensive patients).

Results The mean hearing thresholds were higher (worse) in all the frequencies on both sides in the hypertensive study group compared with normal subjects. However it was found to be statistically significant when tested using independent sample test ($p < 0.05$) on right ear at 2,000 Hz, 4,000 Hz and 8,000 Hz only. The mean hearing threshold is higher in all frequencies in the presence of retinopathy compared to control. However, the difference was found to be only statistically significant in the mean hearing threshold between grade I and control at 4,000 Hz and 8,000 Hz on both sides and at 1,000 Hz and 2,000 Hz on right ear.

Hypertensive patient with grade I retinopathy had higher pure tone hearing thresholds at 4,000 Hz and 8,000 Hz compared to hypertensive without retinopathy and normal control.

Conclusions Hypertensive retinopathy appears to be associated with high frequency sensor neural hearing loss.

Keywords Hypertension, · Retinopathy · Sensorineural hearing loss

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Introduction

Hypertension is a common chronic disease encountered in the clinical practice in this country. In Malaysia, the prevalence of hypertension amongst adults 30 years and above is estimated at about 29.9% in 1996 (National Health and Morbidity Survey 2) [1–2]. This is equivalent to 2.1 million of the adult population [3]. Poorly controlled blood pressures are associated with increased risk of myocardial infarction, stroke and hypertensive retinopathy which reflect intravascular changes secondary to hypertension. We therefore postulate that hypertensive retinopathy due to chronic uncontrolled blood pressure is associated with similar vascular changes in the internal auditory vessels and thus can potentially causing sensorineural hearing loss since the arterial supply to the inner ear is an end artery. The objective of this study is to determine whether patient with hypertensive retinopathy have a higher mean hearing threshold (worse hearing) compared to normal population. At the same time we also wanted to determine whether the severity of retinopathy has any effects on mean hearing threshold among the hypertensive patients.

Materials and methods

This is a cross-sectional study of hypertensive patients attending the hypertensive clinic in University Malaya Medical Center during the study period. The patients who participated in the study are those, who had no hearing complaints and agreed to participate as volunteers, after being explained and consented to participate in the study.

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Questions about the use of antihypertensive medication and records of blood pressure measurements determined the presence or absence of hypertension. Healthy control consisted of non-hypertensive age and sex matched subjects without hearing or vestibular impairment attending the otolaryngology clinic. Subjects with the past history of ear infection, prolonged exposure to loud noise, history of ototoxic drugs use, history of head or ear trauma, family history of deafness and diabetes mellitus are excluded from the study. All subjects underwent a thorough ear, nose and throat examination to rule out other pathology prior to a pure-tone audiometry. Behavioral air-conduction thresholds for tones were obtained at traditional audiometric frequencies 250 through 8,000 Hz using a diagnostic audiometer (Virtual 320). A conventional bracketing procedure (ASHA 1978) was used for all threshold measures. If participants did not respond to any signal at the output limit of the audiometer, no threshold was recorded for that condition. The audiometer was calibrated in accordance with appropriate ANSI standards (ANSI 1989). All audiometric tests were conducted in a sound-treated room meeting ANSI (1991) standards for ambient noise. All the patients had an ophthalmologic assessment by a single blinded ophthalmologist for hypertensive retinopathy. We used the Keith, Wagener and Barker grading system [4] to grade the severity of hypertensive retinopathy.

According to this classification

Group I: minimal narrowing of the retinal arteries,

Group II: narrowing of the retinal arteries in conjunction with regions of focal narrowing and arteriovenous nicking,

Group III: abnormalities seen in groups I and II, as well as retinal hemorrhages, hard exudation and cotton-wool spots,

Group IV: abnormalities encountered in groups I through III, as well as swelling of the optic nerve head.

All statistical analyzes were performed using SPSS version 12.0 Statistical software. Results are presented as means ±SD. Statistical evaluation was carried out by one way ANOVA test. The level of significance was chosen at $p < 0.05$. Correlations were calculated with Bonferroni post-Hoc tests.

Result

We recruited 56 hypertensive patients and 56 control patients. Thirty-three hypertensive patients had normal retina. Fourteen of the hypertensive patients had grade I retinopathy and nine had grade II retinopathy. There were no patients who had grade III or IV retinopathy. All the controls had normal retina (Table 1). Majority in the study and control were females with 67.9% in the control group and 60.7% in the study subjects. 32.1% in the control group and 39.3% in the hypertensive subjects were males (Table 2). The age group in both study and control group were normally distributed. Majority of patients were in the 60–69 age group (Table 3). The mean age in control and study group was 62.36 and 64.79, respectively. There was no statistically significant difference in the mean age between the study and control group. (Independent sample test: $t = 0.166$) thus concluding that both study and control were age and sex matched (Table 4).

The mean hearing thresholds were higher (worse) in all the frequencies on both sides in the hypertensive study group compared with normal subjects. However it was found to be statistically significant when tested using independent sample test ($p < 0.05$) on right ear at 2,000 Hz, 4,000 Hz and 8,000 Hz only. The underlying reason for this difference

Table 1 Distribution of patient in the study

Grades of retinopathy	No. of patient
I	14
II	9
III	0
IV	0
Normal	33
Control	56
Total	112

Table 2 Age group distribution of study population

	Control		Case		Total	
Age group	No.	%	No.	%	No.	%
40–49	6	10.7	3	5.4	9	8.0
50–59	12	21.4	11	19.6	23	20.5
60–69	25	44.6	28	50.0	53	47.3
70–79	10	17.9	11	19.6	21	18.8
>80	3	5.4	3	5.4	6	5.4
Total	56	100	56	100	112	100

Table 3 Percentage of sex distribution

	Control		Case		Group total	
	Count	Col %	Count	Col %	Count	Col %
Male	18	32.1	22	39.3	40	35.7
Female	38	67.9	34	60.7	72	64.3
Group total	56	100.0	56	100.0	112	100.0

Table 4 Mean age of the study population

	Case control	N	Mean	Std. deviation	Std. error mean
Age	Control	56	62.36	9.863	1.318
	Case	56	64.79	8.538	1.141

could be explained by wear and tear but the information of dominant ear was not collected as part of the data collection (Table 5).

The mean hearing threshold is higher in all frequencies in the presence of retinopathy compared to control. However, the difference was found to be only statistically significant in the mean hearing threshold between grade I and control at 4,000 Hz and 8,000 Hz on both sides and at 1,000 Hz and 2,000 Hz on right ear using the Bonferroni multiple comparisons. There is also significant difference in mean hearing threshold between grade 0 and grade I retinopathy group on left ear at 8,000 Hz. and on right ear at 4,000 Hz. Thisdifference was not statistically significant on right ear at 8,000 Hz. There is no statistically difference in mean hearing threshold between control and grade 0 retinopathy group at all frequencies. There is no significant difference in mean hearing threshold between grade I and II retinopathy group in this study probably because the number of cases with grade II is small.

In summary, hypertensive patients in this study had a higher mean hearing threshold at all the frequencies tested and it is statistically significant on the right ear from 2,000 Hz to 8,000 Hz. Hypertensive patient in the presence of grade I retinopathy changes is associated with statistically significant increase in mean hearing threshold at high frequency 4,000 Hz and 8,000 Hz bilaterally. There is no significant difference in the mean hearing threshold in the hypertensive subject without retinopathy compared to control. There is no statistically difference between grade I and grade II in this study which could be due to the small number of cases with grade II retinopathy (Table 6).

Table 5 Mean hearing threshold between hypertensive and control

	Case control	N	Mean	Std. deviation	Std. error mean
FL250	Control	56	17.68	4.858	0.649
	Case	56	19.55	8.050	1.076
FL500	Control	56	19.20	7.614	1.018
	Case	56	20.89	9.444	1.262
FL1000	Control	56	20.00	7.687	1.027
	Case	56	22.23	10.266	1.372
FL2000	Control	56	24.38	11.444	1.529
	Case	56	26.88	11.699	1.563
FL4000	Control	56	28.48	13.070	1.747
	Case	56	33.13	16.748	2.238
FL8000	Control	56	43.13	18.130	2.423
	Case	56	49.91	21.773	2.910
FR250	Control	56	18.13	6.220	0.831
	Case	56	20.27	9.459	1.264
FR500	Control	56	19.29	7.653	1.023
	Case	56	22.23	10.993	1.469
FR1000	Control	56	19.73	7.829	1.046
	Case	56	22.59	9.534	1.274
FR2000	Control	56	23.13	10.161	1.358
	Case	56	27.86	13.138	1.756
FR4000	Control	56	27.41	12.135	1.622
	Case	56	33.57	17.470	2.335
FR8000	Control	56	39.73	17.848	2.385
	Case	56	49.82	23.683	3.165

FL = Frequency tested on left ear in Hertz
FR = Frequency tested on right ear in Hertz

Discussion

Hypertension is a common chronic disease. Chronic uncontrolled blood pressure can also result in generalized arteriolosclerosis. This vascular narrowing can be seen during fundus examination. In this study, we looked at the end result of chronic hypertension on the vascular changes and correlate it with hearing threshold as the inner ear is supplied by an end artery. Hypertension is an important pathophysiological risk factor in age-related hearing loss. Hypertension have been shown to cause hearing loss in patients [5–7] as well as cochlear damage in animal studies [6–9]. Chronic hypertension has also been implicated in the development of hearing loss [10, 11] Studies have documented that chronic hypertension potentiates noise-induced decreases in cochlear function and the development of histological cochlear damage [12, 13] A significant association among hypertension, age, and hearing loss in an animal model has also been confirmed [14] A positive association has been reported between hearing loss and (a) the degree of stenosis of the internal auditory artery and (b) the degree of spiral ganglion atrophy based on histological studies of temporal bones and brain sections from older adults with hypertension [11].

Hypertensive vascular changes in the retina are related to the severity, duration and age. The eye is the only place in the body where the vessels can be directly observed. Multiple attempts have been made to classify and grade the effects of hypertension on the retinal vessels. Diffuse vascular pathology caused by hypertension will also affect the vessels in the inner ear. When blood flow to the cochlea was compromised, a reduction in DPOAE level

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Table 6 Mean hearing threshold between case and control in the presence of retinopathy

Frequency/Hz	Grade 0		Grade I		Grade II		Control	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
L250	19	7	23	9	17	9	18	5
L500	20	8	26	13	18	7	19	8
L1000	21	8	26	15	21	9	20	8
L2000	25	10	32	14	27	13	24	11
L4000	30	13	43	21	29	17	28	13
L8000	44	19	61	22	52	27	43	18
R250	19	8	24	12	19	10	18	6
R500	21	10	26	12	21	12	19	8
R1000	21	8	28	11	22	10	20	8
R2000	26	11	33	17	27	14	23	10
R4000	30	13	44	23	29	15	27	12
R8000	46	21	61	27	48	25	40	18

L = Left ear
R = Right ear

was noted in a rabbit model [15–17] and in a gerbil model [18]. These animal models suggest that reduction in blood supply will have a corresponding reduction in cochlear function and may created irreversible damage to cochlear integrity. The result showed that hypertensive patient in the presence of hypertensive retinopathy changes had a higher mean hearing threshold in the high frequency. Hypertensive patient in the absence of retinopathy had no significant difference in the mean hearing threshold compare to the control group. We therefore conclude that the vascular narrowing seen in chronic poorly controlled hypertension is associated with high frequency hearing loss. However, bearing in mind that this is a cross-sectional study that there is no cause-effect relation can be inferred from this association. The retinopathy is also a subjective measurement of vascular changes even though all the patients were being assessed by a single blinded ophthalmologist. Moreover, the number of the patient recruited in this study is still small. Based on the result obtained through this study, it is expected that a more significant relationship between the retinopathy changes and hearing loss if high frequency hearing test is used for study. The results of this research, through evidence of association between hypertension and hearing loss, can act as a platform for otorhinolaryngologists, and audiologists to work together with other health professionals concerned with the alterations caused by chronic uncontrolled blood pressure.

Conclusion

Preliminary data from this study suggest that hypertensive retinopathy appears to be associated with high frequency sensory neural hearing loss. The mean hearing thresholds were higher (worse) in all the frequencies on both sides in the hypertensive study group compared with normal subjects (statistically significant only on right ear at 2,000 Hz, 4,000 Hz and 8,000 Hz) and the mean hearing threshold is higher in all frequencies in the presence of retinopathy compared to control. (Statistically significant in the mean hearing threshold between grade I and control at 4,000 Hz and 8,000 Hz on both sides and at 1,000 Hz and 2,000 Hz on right ear).

Limitations of this study include a small number of study group and the lack of level III and IV grade retinopathy. Further more extensive study would be required to confirm these preliminary findings.

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