



Association between hearing loss and hypertension in non ear infection patients in Universitas Gadjah Mada Academic Hospital

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ABSTRACT

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Hearing loss is a common occurrence that can decrease productivity and quality of life. The incidence of hearing loss is often experienced by adults due to several factors, and one influencing factor is cardiovascular disease. Hypertension is known to have an effect on decreasing inner ear vascularization that will result in hearing loss. The objective of this study was to evaluate the association of hearing loss and hypertension in non-ear infection patients. This case-control study recruited subjects who underwent audiometric examination at the Universitas Gadjah Mada Academic Hospital, Yogyakarta, from June 2018 - July 2019. Hypertension was determined based on the results of blood pressure examination based on JNC 8 criteria. Hearing threshold value was taken from pure tone audiometry. The association of hypertension with hearing loss was analysed in each group and between study groups. Sixty patients who underwent audiometric examination divided into two groups with 30 patients in each group were involved in this study. There was a significant relationship between hypertension and hearing loss (OR=13.1; 95%CI: 3.8-45.0; p= 0.001). Hypertension acts as a variable that significantly affects the incidence of hearing loss. Patients with hypertension have a greater risk of hearing loss compared to patients without hypertension.

ABSTRAK

Gangguan pendengaran adalah kejadian umum yang dapat menurunkan produktivitas dan kualitas hidup. Kejadian gangguan pendengaran sering dialami oleh orang dewasa karena berbagai faktor salah satunya adalah penyakit kardiovaskular. Hipertensi diketahui menyebabkan penurunan vaskularisasi telinga bagian dalam yang berakibat gangguan pendengaran. Tujuan penelitian ini adalah mengkaji hubungan antara gangguan pendengaran dan hipertensi pada pasien tanpa infeksi telinga. Penelitian ini adalah penelitian kasus-kontrol yang melibatkan pasien yang menjalani pemeriksaan audiometri di Rumah Sakit Akademik Universitas Gadjah Mada, Yogyakarta, dari Juni 2018 - Juli 2019. Hipertensi ditentukan berdasarkan hasil pemeriksaan tekanan darah menurut kriteria JNC 8 dan nilai ambang pendengaran diambil dari audiometri nada murni. Hubungan hipertensi dengan gangguan pendengaran dianalisis pada setiap kelompok dan antar kelompok penelitian. Enam puluh pasien yang menjalani pemeriksaan audiometri yang terbagi dalam dua kelompok dengan masing-masing kelompok 30 pasien dilibatkan dalam penelitian ini. Hasil penelitian menunjukkan ada hubungan nyata antara hipertensi dan gangguan pendengaran dengan (OR=13,1; 95%CI: 3,8-45,0; p=0,001). Hipertensi merupakan variabel yang secara signifikan mempengaruhi kejadian gangguan pendengaran. Pasien dengan hipertensi memiliki risiko lebih besar mengalami gangguan pendengaran dibandingkan dengan pasien tanpa hipertensi.

Keywords:

hypertension;
hearing loss;
hearing threshold value;
audiometry;
risk factor;

INTRODUCTION

Hearing loss is an increasing global health problem. The World Health Organization (WHO) in 2018 estimated around 466 million people in the world experienced hearing loss, which increased from 360 million in 2012.^{1,2} A study conducted in USA showed that hearing loss directly affects 23% of Americans aged 12 years or older.³ According to the Indonesian Basic Health Research Ministry of Health 2013 (Riskasdas Kemenkes 2013), the prevalence of hearing loss was 2.6% of the total Indonesian population with the highest distribution at the age > 45 years.⁴

Meanwhile, hypertension is also one of the high burden cardiovascular diseases in the world, with an estimated 349 million people in high-income countries and 1.04 billion people in low- and middle-income countries who had hypertension in 2010.⁵ In Indonesia, based on research from National Health Survey (*Survei Kesehatan Nasional/Surkesnas*) 2001, the proportion of hypertension were 27% in men and 29% in women. *Surkenas* surveys in 1992, 1995 and 2001 found that circulatory system diseases always ranked first.⁶

Hearing loss can reduce productivity due to it makes communication difficult and associated with early death, depression and dementia.^{7,8} A recent review reported that hearing loss in midlife (aged 45–65 years) is associated with the risk of dementia in future.⁹ Patients with hearing loss will have difficulties in doing work and study tasks, which will reduce their quality of life and their quality of competitiveness as human resources. Patients with cardiovascular diseases are classified as a vulnerable group.⁴

A preliminary study in Mexico reported that participants with hypertension exhibited more hearing loss compared with participants

normotension.¹⁰ In 2013 in India, Agarwal *et al.*¹¹ reported that patients with hypertension have a greater hearing threshold than those without hypertension. However, hospital-based local studies concerning the relationship between cardiovascular profiles and hearing loss are limited in Indonesia. In this study, we reported the relationship between hearing loss and hypertension in non ear infection patients in Universitas Gadjah Mada Academic Hospital, Yogyakarta.

MATERIALS AND METHODS

Design and site of study

This was an observational analytic case-control study to investigate the relationship between hearing loss and hypertension by comparing hearing threshold value between hypertension patients and normotension. The protocol of the study has been approved by the Medical and Health Research Ethics Committee (MHREC) of the Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada, Yogyakarta (Ref. KE/FK/0914/EC/2018).

The study was conducted in Universitas Gadjah Mada Academic Hospital, Yogyakarta from June 7th 2018 - July 7th, 2019. Target population of this study were patients with hearing loss. Available population of this study were patients with hearing loss in Universitas Gadjah Mada Academic Hospital, Yogyakarta. Sample population of this study were patients with hearing loss that met the inclusion and exclusion criteria

Population and samples

The inclusion criteria of the study were patients who have data of audiometry result and blood pressure in medical record. The exclusion criteria were patients who suffer ear infection

including outer, middle and inner ear infection and patients who have undergone ear surgery that affects their hearing function. Subjects who met the inclusion criteria were classified into 2 groups i.e. normal hearing and hearing loss. Total number of the sample in this study was 60 subjects and then divided into two groups with 30 subjects in each group.

Statistical analysis

The relationship between hypertension with decrease of hearing threshold with comparison to mean blood pressure (systole and diastole) were analyzed using student t-tests. The differences in the proportions of patients with hypertension and normotension

between groups of hearing loss and normal hearing loss were analyzed using the χ^2 test by calculating odds ratio (OR) and relationships with other variables using multivariate analysis.

RESULTS

Based on the medical record data there were 30 patients with normal hearing as a control group and 30 patients with hearing loss as a case group. In a control group average age was 31.23 ± 15.31 years and in hearing loss case group average age was 59.13 ± 18.62 years. The characteristics subject are presented in TABLE 1. Subjects with hearing loss were older than subjects with normal hearing ($p < 0.000$).

TABLE 1. Characteristics of patients

Characteristics of subject	Normal hearing [n (%)]	Hearing loss [n (%)]	p
Age (mean \pm SD year)	31.23 \pm 15.31	59.13 \pm 18.62	
• < 17	3 (10.0)	1 (3.3)	
• 17-25	9 (30.0)	2 (6.7)	
• 26-35	8 (26.7)	0 (0.0)	
• 36-45	5 (16.7)	4 (13.3)	0.000
• 46-55	1 (3.3)	3 (10.0)	
• 56-65	3 (10.0)	6 (20.0)	
• >65	1 (3.3)	14 (46.7)	
Gender			
• Female	17 (56.7)	14 (46.7)	0.606
• Male	13 (43.3)	16 (53.3)	

There were 31 women patients with 17 normal hearing and 14 with hearing loss and 29 men patients with 13 normal

hearing and 16 with hearing loss. No relationship between gender and hearing loss was observed in this study ($p=0.606$).

TABLE 2. Association of hypertension and hearing loss

Hypertension	Group		Σn [n (%)]	p	OR (CI 95%)
	Normal Hearing [n (%)]	Hearing Loss [n (%)]			
No	23 (76.7)	6(20.0)	29(48.3)	0.001*	13.1 (3.80-45.00)
Yes	7(23.3)	24 (80.0)	31(51.7)		

CI: Confidence Interval; OR: Odds Ratio

Among 30 subjects with normal hearing function, 23 patients (76.7%) had normotension and 7 patients (23.3%) had hypertension. Furthermore, among 30 subjects with hearing loss, 6 patients (20%) had normotension and 24 patients (80%) had hypertension. Asignificant

relationship between hypertension and hearing loss was observed (OR=13.1; 95%CI:3.80-45.00; p=0.001). Subjects with hypertension had more than 13 times greater risk of hearing loss compared to subjects with normotension (TABLE 2).

TABLE 3. Pure tone threshold (mean ± SD) in subject with hypertension and normotension

Pure tone threshold (Hz)	Normotension	Hypertension
Right ear		
• 250	30.35± 20.99	37.74 ± 21.67
• 500	38.21 ± 24.35	43.70 ± 21.67
• 1000	34.64 ± 27.61	43.70 ± 21.90
• 2000	28.75 ± 28.33	45.00 ± 26.77
• 4000	26.78 ± 30.58	48.70 ± 28.98
• 8000	30.17 ± 29.98	53.06 ± 29.62
Left ear		
• 250	31.07 ± 25.50	46.93 ±20.52
• 500	36.60 ± 26.70	51.93 ± 20.52
• 1000	34.82 ± 27.46	52.25 ± 23.55
• 2000	31.60 ± 26.98	50.16 ± 26.31
• 4000	34.64± 32.51	59.35 ± 27.49
• 8000	38.57 ± 30.72	64.05 ± 27.00

TABLE 3 provides the pure tone threshold results of both ears measure at frequencies ranging between 250 and 8000 Hz in subjects with hypertension

and normotension. Increasing of hearing threshold was greater in all frequencies for subjects with hypertension group compare to subject with normotension.

TABLE 4. Hearing loss grade in subject with hypertension and normotension

Hearing loss grade	Normotension [n (%)]	Hypertension [n (%)]
Right Ear		
• Slight impairment	1 (3.3)	8 (26.7)
• Moderate impairment	2 (6.7)	8 (26.7)
• Severe impairment	2 (6.7)	4 (13.3)
• Profound impairment	1 (3.3)	4(13.3)
Left Ear		
• Slight impairment	0 (0.0)	4 (13.3)
• Moderate impairment	4 (13.3)	9 (30.0)
• Severe impairment	2 (6.7)	6 (20.0)
• Profound impairment	0 (0.0)	5 (16.7)

TABLE 4 showed hearing loss grade of both ears based on WHO criteria of hearing loss grade.¹² It was grouped into slight impairment, moderate impairment, and severe impairment and profound impairment in subjects with normotension and subjects with hypertension. Hearing loss in any grade were found mostly in subject with hypertension.

DISCUSSION

The human ear is divided into three main parts: outer, middle, and inner. The middle ear covers the area between the tympanic membrane and the inner ear capsule, consisting of the tympanic cavity, auditory bone, auditory muscles and their supporting organs: auditory tube, and mastoid air cell system. The tympanic cavity from superior to inferior is divided into the epithelium at the apex, mesotympanic and hypotympanic cavities.^{13,14}

The physiology of hearing is the process by which sound waves are captured by the auricle then passed into the outer ear canal and they vibrate the tympanic membrane which then moves the hearing bones of the malleus, incus and stapes. In the middle ear, there are impedance adjustments that transform the sound vibration pressure with low

resistance to the cochlear hydrodynamic resistance by utilizing the wide difference of the tympanic membrane with the ovale fenestra.¹³

Hearing loss is one of the factors that can affect a patient's quality of life. When it happens to adults, it will gradually lead to verbal communication disorders. In most adults, the occurrence of hearing loss starts from the age of 30 years, and will increase progressively throughout the ageing process. Men will experience hearing loss faster compared to women. Disorders of hearing function can result in psychosocial disorders, such as low self-esteem, isolation, depression and irritability, which can interfere with the quality of life of individuals.¹¹

According to data from the Association of American Speaking Language Hearing (ASHA), there are currently 28 million people in the US who are suffering from some type of hearing loss, and 80% of them are irreversible problems. This data also showed that 4.6% of the affected individuals are between 18 and 44 years, 14% of individuals are between 45 and 64 years, and 54% of the population over 65 years suffer from hearing loss. The main risk factor are metabolic changes, blood supply problems, infection, trauma, smoking, high BMI (body mass index) and hereditary factors.^{11,15}

All living cells in the human body depend on the supply of oxygen and nutrients to maintain their function, and this process depends on the functional and structural aspects of the heart and blood vessels. Hypertension, the most common vascular disorder, can cause structural changes of the heart and blood vessels. High pressure on the vascular system can cause bleeding in the inner ear that can cause progressive hearing or sudden hearing loss.^{16,17}

The pathology of the circulatory system can directly affect the hearing process in several ways. One of the vascular mechanisms known is increased blood viscosity, which decreases capillary blood flow and ends with a reduction in oxygen transport, causing tissue hypoxia which then can cause hearing complaints and hearing loss in patients. In addition, arterial hypertension can also cause changes in ionic potential which can cause hearing loss.¹⁸

In animal studies showing reduced endocochlear potential and hearing loss occurring promptly after an anoxic event.¹⁹ It was hypothesized that hypertension may compromise the vascular supply that leading to hearing loss.²⁰ Others studies also said that hearing loss related to a microcirculatory insufficiency that occurs due to vascular occlusion caused by emboli, haemorrhage or vasospasm. It was happen because of a syndrome of hyperviscosity or microangiopathy caused by diabetes mellitus or hypertension.¹¹

Early detection, early treatment and early improvement of hearing loss case is important for a better prognosis. Good prognosis in the hearing recover was associated with early treatment the first seven days of symptoms and improvement rate at 1–2 weeks after treatment predicts the long-term prognosis for recovery of hearing level in patients.²¹

CONCLUSIONS

Hypertension can influence hearing loss. Patients with hypertension have a greater risk of hearing loss than subjects with normotension. It is recommended that patients with hypertension have a hearing examination so the management can be conducted earlier.

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