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Hearing loss and hypertension: exploring the linkage

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Abstract

Background: The inner ear vascular system may be disrupted by systemic hypertension causing inner ear hemorrhage and resulting in progressive or sudden hearing loss. Constriction of the labyrinthine artery secondary to atherosclerosis seen in high BMI and waist/hip circumference—risk factors of hypertension—could also occur with resultant hearing loss. Thus, hypertension could predispose to increased risk of hearing loss. This cross-sectional study assessed the hearing thresholds of hypertensive patients and sought to determine the association between hypertension and hearing loss among patients attending cardiology clinic in tertiary hospital in Nigeria.

Results: The study population was 500 individuals equally divided into subject and control arms. The mean age of the subjects and controls was 47.2 ± 7.4 years and 46.9 ± 7.5 years respectively. Hearing loss—mainly mild sensorineural hearing loss—was seen in 30% of the subjects and 0.4% of the controls. The hearing loss was bilateral in all subjects and slightly worse in the right ears. The hearing loss worsened with increased age, severity, and duration of hypertension; however, there was no association between the hearing loss and body mass index.

Conclusion: There is an association between hypertension and hearing loss, though most of the hypertensive subjects had mild sensorineural hearing loss. The prevalence and severity of the hearing loss worsens with the degree of hypertension. Incorporating regular audiological assessment for hypertensive patients could improve the quality of care for hypertension and quality of life for hypertensive patients.

Keywords: Blood pressure, Hearing loss, Hearing threshold, Hypertension, Body mass index

Background

Hypertension is a chronic medical condition characterized by elevated arterial blood pressure [1]. According to WHO/International Society of Hypertension guidelines, hypertension is defined as systolic blood pressure ≥ 140 mmHg and diastolic blood pressure ≥ 90 mmHg, and/or self-reported treatment of hypertension with antihypertensive medications taken in preceding 2 weeks. The classification of adult blood pressure is divided into the normal group of systolic blood pressure (SBP) < 120 mmHg and diastolic blood pressure (DBP) < 80 mmHg, prehypertension SBP: 120-139 mmHg and DBP: 80-90 mmHg, first-degree hypertension SBP: 140-159 mmHg and DBP: 90-99 mmHg, second-degree hypertension SBP > 160 mmHg and DBP > 100 mmHg [2].

Hypertension cuts across all socioeconomic strata and it is a global public health challenge [3, 4]; the burden of hypertension (and other non-communicable diseases) is rapidly increasing, especially on the African continent which may be the most affected region in the world [5–7]. Hypertension affects about 1 billion people globally and it is the main risk factor for many other cardiovascular diseases [8–10]. The overall crude prevalence of hypertension in Nigeria ranges from 6.2 to 48% and 10 to 47.3% in males and females respectively [11], this may form a large proportion of the total burden of hypertension in Africa because Nigeria is the most populous black nation with an estimated population of over 170 million [8]. This burden of hypertension may continue

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to increase due to the increasing adult population and lifestyle changes of Nigerians [12, 13].

Hypertension is an independent risk factor for hearing loss due to the possible impact on the microcirculation of the inner ear; the subsequent degeneration of the inner ear will lead to hearing loss. The effect of hypertension on the inner ear can be manifested by thrombus formation secondary to damage to arterial inner lining from the increased pressure [14]. Occlusion of blood flow can lead to cell death in distal structures. Atherosclerosis can also occur in the cochlear arteries following long standing hypertension with fat collection in the damaged arteries. High body mass index (BMI) and large waist circumference, which are risk factors of hypertension, are associated independently with an increased risk of hearing loss [15]. Obesity-related atherosclerosis may lead to stiffening and constriction of the internal auditory artery and reduction in cochlear blood flow. This can lead to capillary constriction within the stria vascularis, cell death, and hearing loss [16].

Long-standing hypertension has been reported as a possible cause of hearing impairment in some adult population. Studies have shown a link between hypertension and hearing loss. Some of these studies have also shown relationship between the duration and severity of hypertension and the prevalence and degree of hearing loss [17–20].

Hearing impairment is a neglected public health problem in developing countries [21], even though about half of all cases of hearing impairment are avoidable through prevention, early diagnosis, and management [22, 23]. The large burden of hypertension in Africa may contribute to the huge burden of hearing impairment in the region. Therefore, there is a need for further studies to validate the association between hearing loss and hypertension. This will serve as a basis for a greater integration between cardiologists, ENT surgeons, audiologist, speech therapists, and other healthcare professionals to improve the quality of care and rehabilitation of individuals with hearing loss. This study therefore sought to determine the prevalence, patterns, and types of hearing loss among individuals with arterial hypertension, and the association between hearing loss, the degree of hypertension, and the body mass index.

Methods

This was a hospital-based cross-sectional study conducted among hypertensive patients and an equal number of age-matched and sex-matched non-hypertensive subjects. Consenting adults aged 18-59 years who met the eligibility criteria were randomly recruited from the Cardiology Medical Outpatients' clinic between February and June 2019. The inclusion criterion was a diagnosis of systemic arterial hypertension while exclusion criteria were positive family history of hearing impairment, history of prolonged exposure to noise, ongoing ear disease or history of ear infection, ototoxic drugs (including diuretics), and co-morbidities such as diabetes mellitus, hyperlipidemia, stroke, and chronic kidney disease. The control group included healthy adult patients' relatives and hospital staff without hypertension or any of the exclusion criteria. A sample size of 250 participants in each arm was determined based on a similar study that gave a prevalence of 16.4% [17] as hearing loss in hypertensive patients. General physical examination and otoscopy were done for all participants, those with wax impaction were offered ear syringing before continuing with other aspects of the study. The blood pressure was determined with a mercury sphygmomanometer (Accoson Dekamet, England) from the mean of two readings taken at least 15 min apart after the participants had rested for at least 10 min. Hypertension was defined and classified according to WHO/International Society of Hypertension guidelines [2]. Weight was determined with a weighing scale RGZ-160 (Lincoln Mark Medical England) and height assessed with a stadiometer RGZ-160 (Lincoln Mark Medical, England). The values obtained were recorded in kilograms and meters respectively and rounded up to two decimal points. The body mass index (BMI) was calculated and categorized according to WHO standard: BMI < 18.5 kg/m^2 as underweight, 18.5-24.9 kg/m^2 as normal weight, 25.0-29.9 kg/m^2 as overweight, 30-3 4.9 kg/m^2 as class I obesity, 35.0-39.0 kg/m^2 as class II obesity and BMI > 40.0 kg/m^2 is classified as class III obesity [24]. Waist and hip circumferences were measured with a tape rule and the values were recorded in centimeters. Waist to hip ratio was classified according to WHO standard: high risk > 1.0 (men), > 0.85 (women), moderate risk 0.9-1.0 (men), 0.80-0.85 (women), and low risk < 0.90 (men) and < 0.80 (women) [25]. Tympanometry and pure tone audiometry were done in a sound - proof audiology booth with a duly calibrated tympanometer (AT 235 Interacoustics) and diagnostic audiometer (AD 629 Interacoustics) respectively. The tympanograms were classified to type A, B, C, A_S, or A_D [26]. Hearing threshold was classified according to WHO: normal

Table 1 Age distribution of the participants, mean blood pressure values among participants

Age category (years)	Subjects *N* (%) *N* = 250	Controls *N* (%) *N* = 250
20-29	4 (1.6)	6 (2.4)
30-39	36 (14.4)	39 (15.6)
40-49	101 (40.4)	97 (38.8)
50-59	109 (43.6)	108 (43.2)

Table 2 Degree of hypertension and distribution of hearing status among the participants

Hypertension severity	Hearing status			*p* value
	Normal hearing *N* (%)	Hearing loss *N* (%)	Total	
First degree hypertension	153 (76.2)	48 (23.8)	201	0.01
Second degree hypertension	22 (44.9)	27 (55.1)	49	

hearing threshold (< 25 dB), mild hearing loss (26-40 dB), moderate hearing loss (41-55 dB), moderately severe hearing loss (56-70 dB), severe hearing loss (70-90 dB), and profound hearing loss (> 90 dB) [27]. The hearing thresholds in the better ear were used for further analysis. Chi-square test was used to determine the relationship between categorical variables, and Students *t* test was used to determine the relationship between quantitative variables. Linear regression was done to test for association between variables. The level of significance was set at a *p* value of less than 0.05.

Results

A total number of 500 participants participated in the study. The mean age of the subjects was 47.2 ± 7.4 years while that of the control group was 46.9 ± 7.5 years (Table 1). Male to female ratio of the subjects was 1:1.7 while that of the control was 1:1.9. All the hypertensive patients were right-handed.

First degree hypertension was seen in 201 subjects while the remainder had second degree hypertension (Table 2). Majority (96.8%) of the hypertensive participants studied had normal tympanogram in both ears while the remaining 3.2% had either type A_s, B, or C tympanogram. Hearing loss was present in 75 subjects (30.0%) while only 1 (0.4%) of the controls had hearing loss (P = 0.0001), among the subjects with stage 1 hypertension, 23.8% had hearing loss (see Table 2 and Fig. 1). Mean pure tone average was slightly worse in the right ear than in the left in both groups. The pure tone audiograms of the subjects with hearing loss were sloping pattern in majority (95%) while the rest (5%) had a flat pattern; 96% of the hearing loss cases were sensorineural hearing loss, while the remainder was mixed hearing loss.

Out of the 75 subjects with hearing loss, 60 subjects had diagnosis of hypertension of greater than 3 years' duration. Age was associated with increased prevalence of hearing loss, the older age group had higher prevalence of hearing loss compared to the younger age group, and no relationship was seen between hearing loss and gender among the hypertensive subjects. Thus, age, severity, and duration of hypertension were found to have statistically significant association with increased prevalence of hearing loss (Table 3).

Majority of the hypertensive subjects were overweight, but the low-risk category of waist-hip ratio was predominant among the subjects. Increase in the BMI and the waist-hip ratio was not associated with increased prevalence of hearing loss (Table 4).

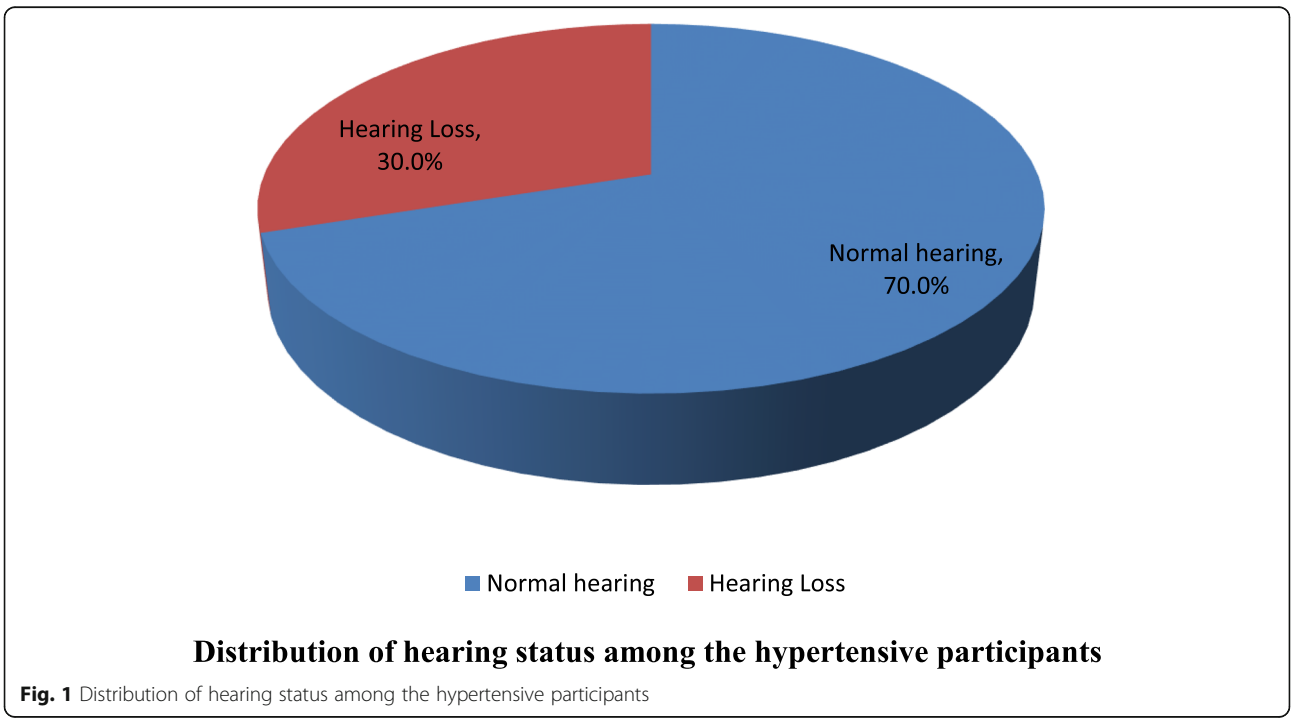

Fig. 1 Distribution of hearing status among the hypertensive participants

Table 3 Association between age, gender, severity, and duration of hypertension with hearing status among subjects

Variables	Hearing status *N* (%)			*p* value
	Normal hearing	Hearing loss	Total	
Severity				0.010
First degree	153 (76.2)	48 (23.8)	201	
Second degree	22 (44.9)	27 (55.1)	49	
Duration of hypertension				0.0001
Less than 1 year	16 (72.7)	6 (27.3)	22	
1-3 years	79 (89.8)	9 (10.2)	88	
> 3 years	80 (57.1)	60 (42.9)	140	
Age group				0.0001
20-29	3 (75.0)	1 (25.0)	4	
30-39	35 (97.2)	1 (2.8)	36	
40-49	72 (71.3)	29 (28.7)	101	
50-59	65 (59.6)	44 (40.4)	109	
Sex				0.555
Male	63 (70.0)	27 (30.0)	90	
Female	112 (70.0)	48 (30.0)	160	

Majority of the subjects (79.2%) use calcium channel blockers either as a single drug or in combination with other class of antihypertensives, 34.4% use angiotensin II receptor blockers, 23.2% use angiotensin converting enzyme inhibitors, while 11.2% use α-Metildopa as either single drug or in combination with other antihypertensive and 24.4% use antiplatelets in combination with antihypertensive medications. There was no significant association between class of antihypertensives used and hearing loss.

After multivariate analysis, severity of hypertension, older age, duration of usage of anti-hypertensive medications, and post-diagnosis duration of hypertension were observed to be predictors of hearing loss among the subjects (Table 5).

Discussion

The proportion of hypertensive patients in the study who had hearing loss was 30%; this is like a trend that has been observed in other studies [28, 29]. However, this study showed that the association between hypertension and hearing loss was statistically significant. The huge burden of hypertension in Africa could therefore be a significant contributor to the silent and often overlooked burden of hearing loss on the African continent. Although all subjects with hearing loss had bilateral

Table 4 Relationship between body mass index and wait/hip ratio with hearing status

Variables	Hearing status *N* (%)			*p* value
	Normal hearing	Hearing loss	Total	
BMI grading				0.776
Underweight	1 (100.0)	0	1	
Normal	59 (73.8)	21 (26.2)	80	
Overweight	62 (67.4)	30 (32.6)	92	
Obese	52 (68.4)	24 (31.6)	76	
Others-morbidly obese	1 (100.0)	0	1	
Waist/hip ratio category				0.716
High risk	48 (70.6)	20 (29.4)	68	
Moderate risk	66 (72.5)	25 (27.5)	91	
Low risk	61 (67.0)	30 (33.0)	91	

Table 5 Multivariate analysis of risk factors of hearing loss

Variables	Odds ratio	95% confidence interval	*p* value
Severity of hypertension	2.275	1.194-4.334	0.012
Age (years)	2.277	1.489-3.483	0.0001
Duration of usage of anti-hypertensive drugs	1.372	1.019-1.846	0.037
Post-diagnosis duration of hypertension	2.703	1.617-4.518	0.0001

hearing loss, yet, the hearing threshold was slightly worse in the right ear compared to the left ear. This may be related to the handedness of the hypertensive subjects, who were all right-handed. The handedness has been suggested as likely cause of prolonged noise exposure in the corresponding ear [30, 31].

The predominance of SNHL in the hypertensive subjects [31, 32] could be secondary to microcirculatory insufficiency in the inner ears due to the microangiopathy caused by hypertension [33, 34].The observed SNHL was mainly of the mild classification, though mild and moderate SNHL have been reported by some other studies of hearing loss in hypertensive patients. The differences in the observations reported may be due to difference in ages of the study participants—studies with older participants tend to report worse category of hearing loss [20, 28, 32]. It was observed that while about a quarter of participants with stage 1 hypertension had hearing loss, at least half of the participants with stage 2 hypertension developed hearing loss demonstrating a progressively increasing prevalence of hearing loss with worsening severity of the hypertension [20, 28]. A similar observation of increase in prevalence of hearing loss with increased duration of the hypertension was also observed [31]. However, the class of antihypertensive drug used was not significantly associated with hearing loss. These observations demonstrated the negative impact of hypertension on the inner ear with corresponding worsening of the hearing acuity. While some authors had identified association of BMI with the increased risk of hearing loss [17], this observation was not confirmed in the index study. We attribute our observation to the study participants being mainly in normal or overweight BMI category and in the low-risk group of waist-hip ratio [35].

Conclusions

There is a demonstrable association between systemic arterial hypertension and hearing loss. The observed hearing loss is mainly sensori-neural, and it worsens with both the severity and duration of hypertension. Incorporating regular audiological assessment for hypertensive patients could improve the quality of care for hypertension and quality of life for hypertensive patients.

Abbreviations

BMI: Body mass index; DBP: Diastolic blood pressure; ENT: Ear, nose, and throat; JNC 7: Seventh Joint National Committee; PTA: Pure tone audiometry; SNHL: Sensorineural hearing loss; SBP: Systolic blood pressure; WHO: World Health Organization

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Authors' contributions

JAB and AAA had a role in the conception, planning, data acquisition and analysis and writing up of the work, and manuscript development. AMA contributed to planning of the study and data acquisition, editing, and revision of the final manuscript. All authors have read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Ethical clearance was obtained from the University of Ibadan and University College Hospital, Ibadan Ethical Review Board (UI/EC/18//0180). Written informed consent was obtained from all the study participants.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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