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Role of Audiometry in Assessing Auditory Acuity in Essential Hypertension: A Cross-Sectional Analysis

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ABSTRACT

Effective communication is essential for human interaction, with the auditory system playing a pivotal role in facilitating this process. It has been postulated that hypertension may independently contribute to the risk of hearing impairment. This study seeks to evaluate the relationship between elevated blood pressure and hearing function, while controlling for the potential confounding influence of noise pollution on auditory impairment. Additionally, it aims to explore any association between the duration of hypertension and hearing impairment. A cohort comprising 78 hypertensive patients and an equal number of normotensive individuals were recruited for this study. Participants were selected based on predefined inclusion and exclusion criteria. Subsequently, blood pressure measurements were obtained, followed by audiometric evaluations to assess hearing acuity according to established protocols. The collected data were analyzed using appropriate statistical methods. Hypertensive individuals exhibited higher hearing thresholds across all frequencies, both in terms of air conduction and bone conduction. Statistical analysis revealed significant differences in hearing thresholds between hypertensive and normotensive groups across all frequencies tested and in both ears. Despite the observed increases in thresholds, they remained within the range considered normal, likely due to the hypertensive cases being under treatment, resulting in mild hypertension.The findings of this study indicate a notable elevation in hearing thresholds among individuals with hypertension compared to their normotensive counterparts. However, no significant correlation was identified between the duration of hypertension and auditory thresholds in the present investigation.

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Key Words
Audiometry, hearing acuity, hearing loss, hypertension

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INTRODUCTION

Hearing impairment is not solely defined by the inability to perceive sound but also encompasses individuals with a hearing threshold of 20 dB or better in both ears. When the hearing loss exceeds 35 dB in the better ear, it is classified as "disabling". The World Health Organization estimates that approximately 700 million individuals, or one out of every ten people, will experience disabling hearing loss by the year 2050. This substantial number includes 432 million adults and 34 million children, constituting around 5% of the global population, who will necessitate rehabilitation to address their disabling hearing loss. Additionally, 5 million people worldwide suffer from profound hearing impairment, while 120 million have hearing loss of at least 40 dB, and 200 million experience varying degrees of hearing impairment[1,2].

Hypertension, often asymptomatic, may manifest with symptoms such as headache, dizziness, tinnitus, chest pain, and weakness. Hypertension induces structural changes in the heart and blood vessels. Studies have identified not only high-frequency but also middle and low-frequency hearing loss in individuals with hypertension and comorbid diabetes or hyperlipidemia[3-5]. This hearing impairment may result from cochlear dysfunction, alongside other complications like heart attack, nephropathy, retinopathy, and stroke. Reduced blood flow to the cochlea leads to tissue hypoxia, elevated free radicals, and abnormal ion recycling, ultimately contributing to hearing loss[6-8]. Hemorrhage within the inner ear's vascular system, a consequence of hypertension, can cause sudden or progressive hearing loss[9,10].

There is speculation regarding hypertension's role as an independent risk factor for hearing loss, with some proposing that hypertension accelerates age-related changes in the auditory system. Hypertension may lead to inner ear degeneration by altering microcirculation, thereby hastening the aging process within the auditory system. However, conflicting findings suggest that uncomplicated hypertension may not directly impact hearing acuity [11-12].

This study aims to investigate the influence of hypertension on auditory acuity and resolve the debate regarding whether hypertension alone, excluding noise-induced hearing impairment, contributes to decreased auditory function. Thus, the present research seeks to elucidate the potential association between hearing loss and elevated arterial blood pressure.

MATERIAL AND METHODS

The study group comprised 78 patients diagnosed with hypertension (stages 1 and 2, as per the JNC 7 Criteria) receiving medication, while the control group consisted of 89 individuals residing in the same area without hypertension.

The inclusion criteria for Group N (Normal) encompassed individuals aged 30–55 years who did not have hypertension and were willing to provide consent. Conversely, the exclusion criteria for Group A included factors such as exposure to noisy environments potentially causing noise-induced hearing loss, hypertension, ingestion of ototoxic medications (e.g., streptomycin, gentamycin), kidney disease, metabolic disorders (e.g., diabetes), pregnancy, secondary hypertension, smoking or alcohol consumption, specific hearing disorders (e.g., rubella, head injuries), and specific vascular disorders (e.g., stroke).

For Group H (Hypertension), participants aged 30–55 years with a diagnosis of hypertension and who consented to participate were included, while the exclusion criteria for Group B consisted of exposure to noisy environments, ingestion of ototoxic medications, kidney disease, metabolic disorders, pregnancy, secondary hypertension, smoking or alcohol consumption, specific hearing disorders, and specific vascular disorders.

The methodology involved obtaining informed consent from each participant, followed by a detailed explanation of the procedure. Subjects were then comfortably seated and allowed to relax for 5 minutes before blood pressure measurement. Blood pressure was assessed using both auscultatory and palpatory methods, with two readings taken one minute apart and the average recorded. Before audiometric examination, each subject's ears were examined to rule out any pathology. Auditory acuity assessment utilized pure tone audiometry, with subjects wearing earphones for air conduction assessment followed by bone conduction assessment using a bone vibrator.

Descriptive and inferential statistical analyses were conducted, presenting continuous measurements as Mean ± SD and categorical measurements as number (%). Significance was set at 5%, with analysis conducted using the Student t-test, Chi-square or Fisher Exact test. Statistical software including SPSS, Microsoft Word, and Excel were utilized for data analysis and presentation of results in graphs and tables.

RESULTS AND DISCUSSION

Table 1 presents the average levels of SBP and DBP among individuals categorized as normotensive and hypertensive. Notably, both SBP and DBP exhibited significantly higher values in hypertensive individuals compared to normotensive controls.

In Table 2, the distribution of hypertensive cases is delineated based on the duration of hypertension. Mean SBP and DBP values are provided corresponding to different durations of hypertension cases. It is noteworthy that the majority of cases fell within the 3–5-year duration group. Additionally, all cases met the criteria for Stage 1 hypertension according to JNC 7 guidelines.

Table 1: Baseline blood pressure in the two groups

Blood pressure	Group N	Group H	P-value
SBP (mm Hg)	115.50 ± 5.30	144.20 ± 7.10	<0.05
DBP (mm Hg)	80.20 ± 2.80	91.70 ± 2.70	<0.05

Table 2: Distribution according to duration of HTN

Duration of HTN	n	%	SBP (Mean ± SD)	DBP (Mean ± SD)
1-2 years	14	15.73	142.50 ± 4.30	90.80 ± 2.40
3-5 years	39	43.82	141.20 ± 1.80	92.20 ± 2.50
>5 years	25	28.09	147.00 ± 11.20	93.00 ± 2.70

Table 3: Hearing thresholds (in hertz) in the study groups

Hearing Frequency	Group N	Group H	P-value
AC Right ear			
250	13.60 ± 4.20	17.60 ± 3.40	<0.05
500	12.70 ± 4.70	14.70 ± 3.70	<0.05
1000	12.80 ± 4.70	15.00 ± 3.70	<0.05
2000	13.30 ± 4.60	22.30 ± 3.10	<0.05
4000	15.50 ± 4.40	21.70 ± 3.40	<0.05
6000	14.50 ± 4.10	16.50 ± 2.80	<0.05
8000	13.90 ± 3.70	15.90 ± 3.10	<0.05
BC right ear			
250	17.00 ± 4.80	20.30 ± 3.50	<0.05
500	16.20 ± 4.50	18.10 ± 2.70	<0.05
1000	16.10 ± 4.50	18.20 ± 2.70	<0.05
2000	17.10 ± 4.70	24.20 ± 2.50	<0.05
4000	18.00 ± 4.30	24.10 ± 3.30	<0.05
AC Left ear			
250	13.00 ± 4.40	16.90 ± 3.00	<0.05
500	12.20 ± 4.60	14.30 ± 2.90	<0.05
1000	12.00 ± 4.50	13.80 ± 3.00	<0.05
2000	12.50 ± 4.50	21.50 ± 2.90	<0.05
4000	14.50 ± 4.50	21.70 ± 2.80	<0.05
6000	14.00 ± 4.10	16.00 ± 2.70	<0.05
8000	13.30 ± 3.60	15.50 ± 2.70	<0.05
BC left ear			
250	17.00 ± 4.80	20.20 ± 3.40	<0.05
500	16.00 ± 4.50	18.20 ± 2.70	<0.05
1000	16.20 ± 4.60	18.10 ± 2.70	<0.05
2000	16.80 ± 4.50	24.40 ± 2.50	<0.05
4000	17.90 ± 4.30	24.20 ± 3.30	<0.05

Table 4: Hearing thresholds (in hertz) and duration of HTN in the study groups

Hearing Frequency	1–2 years	3–5 years	>5 years	P-value
AC Right ear				
250	15.70 ± 4.20	17.90 ± 3.60	17.30 ± 2.60	0.172
500	14.20 ± 3.80	14.30 ± 3.50	16.10 ± 3.70	0.18
1000	14.40 ± 4.20	15.80 ± 3.70	13.90 ± 3.30	0.42
2000	22.00 ± 4.60	22.40 ± 3.00	22.60 ± 2.60	0.9
4000	20.80 ± 3.30	21.60 ± 3.60	21.40 ± 3.50	0.71
6000	14.40 ± 1.80	16.10 ± 2.60	17.00 ± 3.20	0.105
8000	17.70 ± 3.90	15.50 ± 2.90	15.40 ± 2.90	0.205
BC Right ear				
250	20.10 ± 3.80	21.30 ± 3.70	19.10 ± 2.90	0.095
500	17.90 ± 3.70	17.50 ± 3.70	19.20 ± 2.10	0.105
1000	18.80 ± 3.60	17.90 ± 2.60	18.20 ± 2.50	0.69
2000	24.00 ± 4.50	24.50 ± 2.30	24.40 ± 1.80	0.805
4000	24.00 ± 3.60	24.50 ± 3.00	24.10 ± 3.80	0.882
AC Left ear				
250	15.80 ± 4.00	16.70 ± 2.80	17.30 ± 2.60	0.425
500	14.50 ± 3.10	13.50 ± 2.80	14.70 ± 2.90	0.255
1000	13.80 ± 3.40	13.50 ± 2.80	14.70 ± 2.90	0.395
2000	21.80 ± 3.60	21.50 ± 2.70	21.30 ± 2.90	0.945
4000	21.80 ± 2.60	21.50 ± 3.10	21.90 ± 2.60	0.872
6000	15.70 ± 1.70	15.90 ± 2.40	16.00 ± 3.80	0.952
8000	16.20 ± 2.30	15.90 ± 2.80	15.70 ± 3.10	0.922
BC Left ear				
250	20.10 ± 3.60	20.50 ± 3.50	20.90 ± 3.30	0.802
500	17.90 ± 3.70	17.50 ± 2.60	19.10 ± 2.10	0.105
1000	17.90 ± 3.70	17.50 ± 2.60	19.10 ± 2.10	0.15
2000	25.10 ± 2.50	24.30 ± 2.40	24.10 ± 2.70	0.655
4000	24.50 ± 3.90	24.30 ± 2.80	23.80 ± 3.90	0.872

Tables 3 depict the audiometric thresholds for various frequencies in the left and right ears of normotensive and hypertensive individuals. Hypertensive subjects demonstrated higher thresholds across all frequencies for both air and bone conduction. However, these thresholds remained within the normal range due to the management of cases, resulting in mild hypertension.

In Tables 4, the audiometric thresholds for different frequencies are presented according to duration-based subgroups of hypertensive individuals. No significant alterations in auditory thresholds for various frequencies were observed among subgroups, as the mean SBP and DBP values did not exhibit significant differences within these subgroups.

The study meticulously controlled for various confounding factors including body mass index, age, gender, and noise pollution, focusing solely on the impact of HTN on hearing levels among cases and controls. Hypertensive individuals exhibited higher thresholds across all frequencies for both air and bone conduction, yet remained within normal limits due to ongoing treatment, indicating mild hypertension. Duration-wise analysis revealed nonsignificant mean systolic and diastolic blood pressure values among hypertensive subjects, with no significant changes observed in auditory thresholds across different frequencies among duration-wise subgroups.

Hypertension is associated with structural changes in the heart and blood vessels[5], while regional and racial variations in blood pressure and hypertension prevalence are influenced by environmental and genetic factors[13]. Hemorrhage within the inner ear vascular system due to hypertension can lead to sudden or progressive hearing loss[9]. Increased blood viscosity reduces capillary blood flow, causing tissue hypoxia and subsequent hearing loss in hypertensive individuals [10]. Age-related nerve degeneration in the cochlea, secondary to hair cell degeneration, contributes to declining hearing sensitivity[14,15]. It is suggested that diseases such as hypertension accelerate aging processes in the ears, leading to faster onset of hearing loss[8,11]. Hypertension-induced alterations in microcirculation can cause degeneration of the inner ear, further accelerating aging processes[12]. Ionic changes associated with arterial hypertension may contribute to hearing loss, as evidenced by experiments on genetically predisposed hypertensive rats showing increased potassium concentration in endolymphatic and perilymphatic cells [16]. Sodium retention in hypertension enlarges the extracellular volume, particularly in the inner ear, leading to impaired conduction through inner ear fluids and affecting high and low frequencies[17,18].

Several limitations were observed in this study. Firstly, the sample size was relatively small, potentially limiting the generalizability of the findings. Secondly, the study was conducted over a short duration, with only one-time assessment of auditory acuity in each subject, which may not fully capture changes over time. Lastly, long-term follow-up with repeated assessments would be beneficial to track the trend of change in hearing thresholds with advancing age and level of blood pressure control, providing more comprehensive insights into the relationship between hypertension and auditory function.

CONCLUSION

The study found higher hearing thresholds in hypertensive individuals compared to those with normal blood pressure. However, age and duration of hypertension did not significantly affect thresholds in the younger subjects. It emphasizes the importance of controlling hypertension through lifestyle changes and medications to prevent early onset of hearing loss, and advocates for regular auditory assessments in hypertensive patients.

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