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Assessment Of Cochlear Function Among Hypertensive Patients in Bauchi: A Cross-Sectional Cohort Study

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Background: Hypertension is an important public-health problem, and it has been identified as the leading cause of morbidity and mortality due to the high incidence of end-organ damages. Unlike other complications of hypertension, cochlear dysfunction in hypertensive patients is a hidden and progressive damage that remains undetected (subclinical) for a long time. The aim of this study was to assess the prevalence of subclinical hearing impairment, as well as the type and degree of hearing loss among hypertensive patients in our environment.

Methods: This was a cross-sectional cohort study conducted among adults diagnosed with hypertension previously. Ethical clearance and informed consent were obtained. Previous history of related exposure event (hypertension) and outcome (hearing loss) was assessed. Each participant was then subjected to conventional Pure Tone Audiometry (c-PTA) and Extended High frequency Audiometry (EHA) tests, and findings were analyzed.

Results: One hundred and ninety (190) hypertensive patients were enrolled, among which 107 (56.3%) were females and 83 (43.7%) males. Hypertension was more common in the age group of 51-60 years (26.8%) and 61-70 years (30.5%). The overall prevalence of hearing loss was 41.6%, of which 18.4% had subclinical hearing impairment. The most common type of hearing loss was sensorineural 68 (86.1%), and found to be in varying degrees of 33.8%, 26.5%, 23.5%, and 16.2% for mild, moderate, severe, and profound hearing loss, respectively.

Conclusion: The overall prevalence of hearing loss among hypertensive patients was 41.6%, with a significant proportion (18.4%) having subclinical hearing loss, which is not noticed by the patients. Therefore, routine pure tone audiometric hearing screening for all hypertensives is recommended to enable early detection and treatment of this hearing loss.

Keywords: Hearing loss, Hypertension, Extended High Frequency Audiometry, Pure tone Audiometry, Prevalence, Subclinical hearing loss

INTRODUCTION

Hypertension affects approximately 1 billion people worldwide, with a prevalence among adults population ranging from 26.0–26.8%, and it is expected to rise by about 60% by 2025, with about two-thirds coming from the developing countries [1]. The incidence of hypertension is also high in Africa; about 130 million cases were reported in the year 2010, and it is projected to increase to 216 million cases by the year 2030 [2]. Nigeria, being the most populous country in Africa, contributed significantly to the rising burden of hypertension in Africa, with an estimated prevalence of 42.8% among the general population [3,4].

Hypertension is an important public-health problem, and it has been identified as the leading cause of morbidity and mortality [1]. Complicated hypertension is common in Nigeria, and it has been associated with serious end-organ damage such as nephropathy, retinopathy, neuropathy, and cochlear dysfunction [5,6]. Although, several studies have explained the likely effect of hypertension on the cochlear function, the issue is still under investigation [7,8]

Hearing loss is a hidden disability affecting about 430 million people worldwide, and it was projected that the cases of disabling hearing loss will rise to about 700 million by the year 2050 [8,10]. Fortunately, 50% of cases of hearing loss are preventable through early identification of etiology and prompt treatment [11]. This stressed the importance of early screening and prompt treatment. It is also imperative to note that most cases of hearing loss are irreversible. Once the damage to the cochlear hair cells is severe, the hearing loss is substantial and irreversible. Therefore, all efforts at prevention should be targeted toward primary etiology and risk factors in order to mitigate this problem [12,13].

Various investigation tools have been used to assess hearing impairment and cochlear function; these include conventional pure tone audiometry (c-PTA) [13], extended high frequency audiometry (EHA) [14], distortion product otoacoustic emission (DPOAE) [14], and transient evoked otoacoustic emission (TEOAE) [15,16]. Conventional PTA is a traditional assessment method of cochlear function that is less invasive and commonly available. However, c-PTA may not be able to detect high frequency cochlear damage early. On the other hand, the extended high frequency audiometry (EHA) is defined as a measurement of hearing threshold above the conventional frequency of 8000 Hz [17]. It is of valuable clinical importance because of its high sensitivity in the early detection of cochlear pathology [17]. It has been reported that the effects of hypertension on the cochlear mainly start at the basal turn, thereby affecting the hearing thresholds at higher frequencies early [18]. Therefore, in this study, we employed both c-PTA and EHA in the assessment of cochlear function and screening of hearing impairment among hypertensive patients. The aim of this study was to assess the prevalence of subclinical hearing impairment, as well as the type, and degree of hearing loss among hypertensive patients in our environment.

METHODOLOGY

This was a cross-sectional cohort study conducted at ENT and medical outpatient clinics of Abubakar Tafawa Balewa University Teaching Hospital (ATBUTH), Bauchi, Nigeria. It is an 800-bed capacity tertiary healthcare facility in the capital city of Bauchi, Northeastern Nigeria. About 1000 patients with hypertension are seen every week in the hospital. The PTA is a routine procedure performed every day at ENT clinic.

Ethical approval to carry out the study was obtained from the Ethical Review Committee of the ATBUTH, Bauchi. Informed consent was obtained from each study participant before enrolment in to the study. For inclusion criteria, we included adult patients, 18 years or older diagnosed with hypertension for at least 1 year, who presented at our clinic during the study period. We excluded patients with ear surgery, head injury, ear diseases, sickle cell anemia, use of ototoxic/cytotoxic medications, congenital ear anomalies, or patients with tumors of the external, middle, or inner ear. The subjects were selected using simple random sampling until the required sample size was reached. The study was conducted over a period of 1 year. Previous history of related exposure event (hypertension) and outcome (hearing loss) was assessed.

An interviewer-administered questionnaire, specifically designed for the study, was used to collect sociodemographic and relevant clinical information. Ear examination was performed; those with ear debris or wax were appropriately removed. All participants underwent c-PTA, EHA, blood pressure, and Body Mass Index (BMI) measurements. The blood pressure was measured using the conventional Riva-Rocci/Korotkoff method [19]. The participants were allowed to rest for 5 minutes. A standard sphygmomanometer was used to measure the blood pressure on the right arm with the participant in a sitting position. The first and fifth Korotkoff sounds were considered as the systolic and diastolic blood pressures, respectively. Two readings were taken 15 minutes apart, and the average of the two readings was recorded in mmHg [20]. Hypertension was classified according to the Joint National Committee on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7) Seventh Edition, which is as follows: Normal is < 120/80 mmHg, Prehypertension = 120-139/80-89 mmHg, Stage I hypertension = 140-159/90-99 mmHg, Stage II hypertension ≥ 160/100 mmHg [21].

The c-PTA and EHA were carried out in our institution's audiology room with a soundproof booth that satisfied the International Standard Organization (ISO)-8253–1 criteria [22]. A digital high frequency diagnostic audiometer (Model: Digi RS I, SI. 1309. India) calibrated to the ISO standard was used to perform the c-PTA and EHA. The procedure was explained to each participant before commencement. Each participant sat on a chair in the audiology room, a circumaural headphone was applied. Pure tones were delivered to each ear through the headphones. The hearing thresholds were measured using the modified Hughson-Westlake method [23]. The result of the audiometric test for each ear was recorded separately on an audiogram. The pure tone average for each ear was calculated by dividing the threshold at 500, 1000, 2000, and 4000 Hz by four. For the EHA, the frequencies of 10,000 Hz and 12,000 Hz were considered. The Pure Tone Average of EHA was calculated by dividing the threshold at 10000 and 12000 Hz by two.

The degree of hearing loss will be categorized according to the WHO grading as follows: normal hearing (≤ 25 dB), mild hearing loss (26-40 dB), moderate hearing loss (41-60 dB), severe hearing loss (61-80 dB), and profound hearing loss (>80 dB) [24]. The type of hearing loss will be determined from the tracings on the audiogram, and will be classified as: Sensorineural Hearing Loss (SNHL) = both AC and BC thresholds were > 25 dB; Conductive Hearing Loss (CHL) = Air-Bone Gap (ABG) of 10 dB or more with the BC < 25 dB while AC > 25 dB. Mixed Hearing Loss (MHL) = both AC and BC thresholds were > 25 dB with an ABG of 10 dB or more [13].

The data was analyzed using SPSS software, version 26.0 for Windows (IBM Incorporated, Chicago, Illinois). The data was summarized and presented as quantitative and qualitative variables. Quantitative variables were presented using the mean and standard deviation. While qualitative variables were presented using frequencies, percentages, and charts. Chi-square test was used to compare the relationship between the variables. Tables, bar and pie charts were used to describe some of the variables. Level of statistical significance will be set at P-value ≤ 0.05, 95% confidence interval.

RESULTS

One hundred and ninety (190) hypertensive patients were enrolled, among which 107 (56.3%) were females and 83 (43.7%) were males, with a male-female ratio of 1:1.3. The age range of the patients was 35–90 years, with a mean and standard deviation of 59.6 ± 12.3 years. The majority of the participants engaged in business activities as their occupation 46 (24.2%), and a significant number were retired 39 (20.5%). Hausa natives were the most common ethnic group 75 (39.5%) among the subjects. The details of sociodemographic variables have been presented in Table 1.

Majority of the patients had elevated blood pressure at the time of the study, 164 (86.3%), of which 61 (32.1%), 51 (26.8%), 52 (27.4%), 26 (13.7) had stage II hypertension, Stage I hypertension, and pre-hypertension respectively (Figure 1). Hypertension was more common in the age group of 51-60 years (26.8%), and 61-70 years (30.5%). The systolic blood pressure ranged from 120-180 mmHg, with a mean of 145.1±18.2 mmHg, while the diastolic blood pressure ranged from 70-120 mmHg, with a mean of 88.3±11.8 mmHg. The duration of hypertension from the first time of diagnosis ranges from 1-25 years, with a mean of 11.2±7.6 years. Body Mass Index among the participants ranged from 19.5–39.5 Kg/m^2 with a mean and standard deviation of 26.6±4.5 Kg/m^2

In this study, the participants also presented with ear symptoms such as vertigo 25 (13.2%), tinnitus 36 (18.9%) and hearing loss 44 (23.2%). The prevalence of symptomatic (clinical) hearing impairment was 23.2%, and from Table 2, the overall prevalence of hearing impairment was 41.6%. Hence the prevalence of subclinical hearing impairment among hypertensive patients was 18.4% (41.6 – 23.2).

The result of c-PTA showed that 111 (58.4%) had normal hearing, while 79 (41.6%) had hearing loss of various types and degrees. The pure tone average of the right ear ranged from 15.0-82.5 dB, with a mean of 29.9±19.8 dB, while that of the left ear ranged from 13.75–83.75 dB, with a mean of 30.3±20.2 dB. The most common type of hearing loss was sensorineural 68 (86.1%), other types of hearing loss were conductive hearing loss 4 (5.0%), and mixed hearing loss 7 (8.9%). The degree of sensorineural hearing impairment among hypertensive patients has been shown in Table 3. Among the patients with sensorineural hearing, 33.8%, 26.5%, 23.5%, 16.2% had mild, moderate, severe, and profound hearing loss, respectively. Therefore, the prevalence of severe hearing loss among hypertensive patients is 23.5%. When we compare the relationship between severity of hearing loss and stage of hypertension, there was a statistically significant association between the two variables ($\chi^2 = 115.5$, $p = 0.000$).

The result of EHA showed that 56 (29.5%) had normal hearing, while 134 (70.5%) had hearing loss. The pure tone average of EHA on the right ear ranged from 20.0–110.0 dB, with a mean of 55.9± 29.8 dB, while that of the left ear ranged from 17.5–115.0 dB, with a mean of 56.5±29.2 dB. When we compare the findings of c-PTA and EHA, there was a statistically significant difference in detecting hearing loss between the two methods ($\chi^2 = 32.316$, $p = 0.0001$). Figure 2 showed the comparison of c-PTA and EHA, there was increased detection of hearing loss when EHA (70.5%) was used for the assessment compared to c-PTA (41.6%) among hypertensive patients.

Table 1: Sociodemographic Variables

Variables	Frequency	Percentage (%)
Gender		
Male	83	43.7
Female	107	56.3
Total	**190**	**100.0**
Age		
31-40	11	5.8
41-50	38	20.0
51-60	51	26.8
61-70	58	30.5
71-80	19	10.0
81-90	13	6.8
Total	**190**	**100.0**
Tribe		

Hausa	75	39.5
Fulani	31	16.3
Yoruba	24	12.6
Igbo	13	6.8
Sayawa	16	8.4
Jarawa	24	12.6
Others	7	3.7
Total	**190**	**100.0**

Table 2: Types of hearing loss among the hypertensive patients

Types of hearing loss	Frequency	Percentage (%)
Conductive hearing loss	4	5.0
Mixed hearing loss	7	8.9
Sensorineural hearing loss	68	86.1
Total no of patients with hearing loss	**79**	**100.0**

Table 3: Degree of sensorineural hearing loss among the hypertensive patients

Degree of Sensorineural hearing loss	Frequency	Percentage (%)
Mild Sensorineural	23	33.8
Moderate Sensorineural	18	26.5
Severe Sensorineural	16	23.5
Profound Sensorineural	11	16.2
Total no of patients with Sensorineural hearing loss	**68**	**100.0**

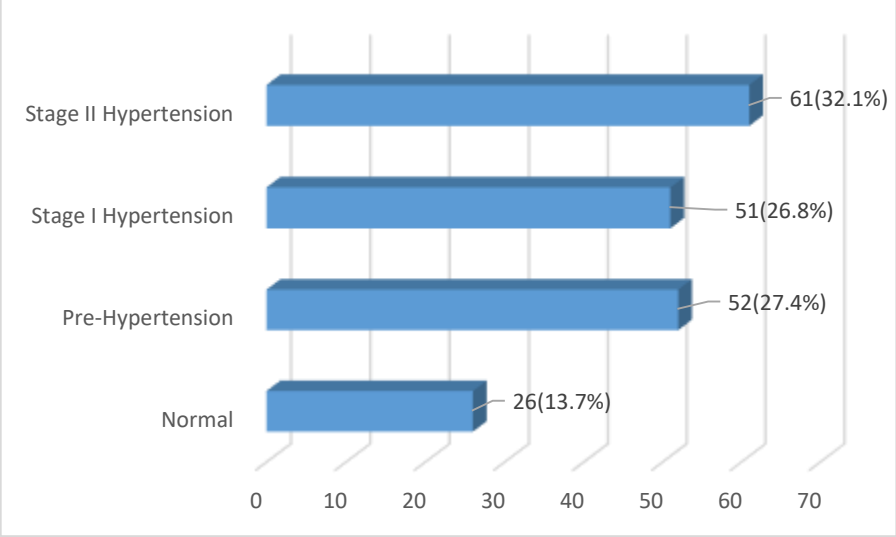

Figure 1: Stage of hypertension among the patients at the time of examination

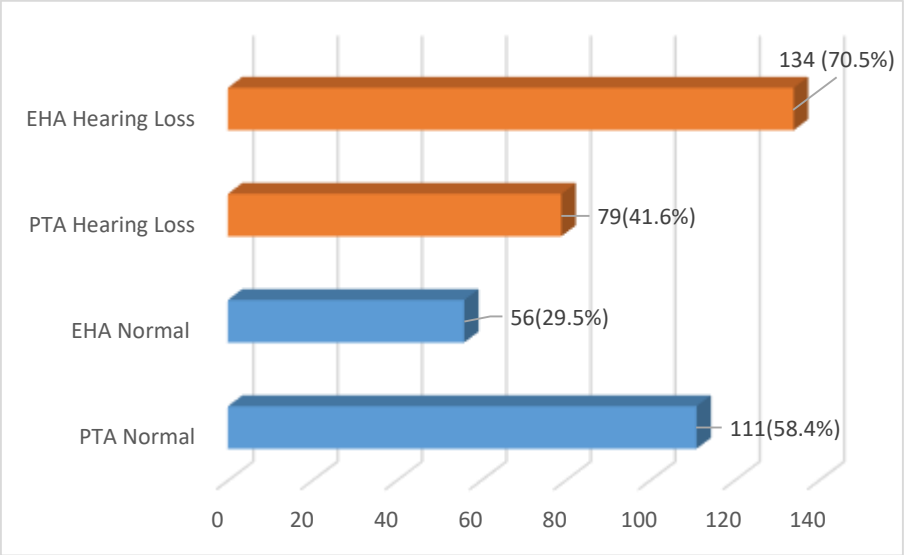

Figure 2: Comparison of Pure Tone Audiometry (PTA) and Extended High Frequency Audiometry (EHA)

DISCUSSION

Hearing is essential for daily communication and social interaction. The ability to interact with others, share ideas, participate in activities, and experience one's surrounding environment greatly depends on hearing. Hearing provides essential information about the environment, including the presence of danger, warning alarms, or shouts [25]. Impairment of hearing is an important public health problem because of its disabling consequences. It is the fourth commonest cause of disability globally, with an estimated annual cost of rehabilitation of over 750 billion dollars [26]. Hearing impairment is a common disease condition worldwide. It is a serious medical and social problem that affects all age groups. According to the World Health Organization (WHO), over 5% of the world's population suffers from hearing loss. It has been observed that the number of people suffering from hearing loss is increasing, and it has been estimated that by the year 2050, nearly 2.5 billion people will be living with some degree of hearing loss [9,27].

In this study, the overall prevalence of hearing loss among hypertensive patients was 41.6%, this is similar to the findings of Osuji et al [28]. in Southern Nigeria, who reported that the prevalence of hearing loss among the hypertensive-diabetic group of patients was 45.0%. In addition, a closely similar prevalence of 38.5% was reported in Northern Nigeria [29]. However, a lower prevalence of 12.38% was found among hypertensive patients in another study [30]. The lower prevalence of hearing loss in their study may be due to the selection criteria they used. The authors selected hypertensive patients between 21–60 years. This may actually reduce the prevalence of hearing loss as elderly patients greater than 60 years were excluded, in whom the hearing loss is usually more common. The result of EHA in this study showed that 70.5% of the patients had hearing loss. However, a lower prevalence (37.4%) of hearing loss among hypertensives was reported in South Africa [31]. Similarly, the EHA pure tone average (44.1 ± 19.2) in their study was lower than our findings (56.5 ± 29.2). The lower prevalence of hearing loss and pure tone average in their study may be due to the small sample size, for which they recruited 106 participants compared to 190 participants in this study.

Regarding the types of hearing loss, sensorineural hearing loss was the commonest (86.1%) type in this study. This is in agreement with findings of a study in Nigeria [30], which reported that sensorineural hearing loss was the most common type (96.6%). In concordance with this report, another study also reported that 96.0% of their hypertensive patients had sensorineural hearing loss [32]. The degree of sensorineural hearing impairment among hypertensive patients in this study was categorized as mild, moderate, severe, and profound hearing loss. A number of our patients had mild hearing loss (33.8%), which correlates with the findings of some authors in our environment, where they observed that 32.7% of their patients had mild hearing loss. However, Agarwal et al. in India reported a higher prevalence of mild hearing loss among their patients. They observed that mild hearing loss was found in 36.7%, 40.4%, and 54.2% of their patients with grade 1, grade 2, and grade 3 hypertension, respectively [33]. This study also found that there was a statistically significant association between the severity of hearing loss and stage of hypertension ($\chi^2 = 115.5$, $p = 0.000$). This is similar to the findings of Babarinde et al. where they observed that age, severity, and duration of hypertension were found to have statistically significant association with increased prevalence of hearing loss [32]. This was corroborated by the findings of other authors in Nigeria [29], and India [33].

Severe hearing loss was observed in 23.5% of our patients. This is contrary to the findings of a study conducted among hypertensive patients in India, where authors reported that 3.0% of their participants were observed to have severe hearing loss. The low proportion of severe hearing loss in their study may be due to the fact that they included newly diagnosed hypertensive patients in their study, which may actually reduce the number of patients with severe hearing loss because the duration of hypertension was found to be associated with increased prevalence of hearing loss among the hypertensive patients [32]. Severe hearing loss is often

obvious; it is usually noticed by patients and their families, and the patient may present to the hospital with a complaint of hearing loss or tinnitus. Unlike subclinical hearing loss, which is overlooked or not usually detected by patients until it is late.

The strength of this study was the ability of the audiometric test to detect some patients (18.4%) with subclinical hearing impairment, which we detected early abnormalities in their cochlear function and have commenced treatment. Therefore, based on these findings, we strongly recommend routine pure tone audiometric hearing screening (especially use of extended high frequency audiometry) for all hypertensive patients to enable early detection and treatment of hearing impairment among these patients. However, one of the limitations was that the study is a hospital-based single center experience, and the findings may not be generalized. Therefore, we recommend that a community-based study or a multicenter/large sample size study should be conducted in order to validate our findings.

CONCLUSION

The overall prevalence of hearing loss among hypertensive patients was 41.6%, with a significant proportion (18.4%) having subclinical hearing loss, which was not noticed by the patients. Therefore, based on these findings, we strongly recommend routine pure tone audiometric hearing screening (especially use of extended high frequency audiometry) for all hypertensive to enable early detection and treatment of hearing impairment among these patients.

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