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Audiological Evaluation in Hypertensive Patients

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ABSTRACT

Every fifth person is affected by impaired hearing. Hearing loss, regardless of commitment, has an impact on people's quality of life, and even when acquired later in life, it develops gradually and impairs spoken communication, affecting sociability, employment, and earning potential. Instead of receiving social sympathy, the person is ridiculed. Among vascular diseases, arterial hypertension is the most common, causing pathological structural changes in the heart and blood vessels. By affecting the vascular system, high blood pressure can produce inner ear bleeding and alter perfusion, resulting in progressive or sudden hearing loss. The present research project is undertaken to serve as a basis for greater awareness of prevention and restoration of hearing loss occurring in association with systemic infirmities like silently progressing arterial hypertension. The purpose of this study is to evaluate the hearing functions of patients of both sexes with hypertension and compare it with normal individuals. To assess the possibility of reversibility of hearing loss with control of hypertension. A prospective comparative study including all patients with hypertension in one group and normal subjects in another who fulfilled the inclusion criteria in Nepalgunj Medical College during the time period of 1st December 2014 to 30th January 2016 was carried out. All the individuals were subjected to a thorough E.N.T. examination. The audiological evaluation was done with Special tests of audiometry. Blood pressure level was estimated at the primary visit and 3 subsequent visits. mild to severe degree of hearing loss was found in 16 subjects (32%) as compared to control cases (statistically significant). There was sensorineural hearing loss in 28 ears (13 Rt. Ears and 15 Lt. Ears) amongst hypertensives (statistically significant). Overall, moderately severe and severe hearing losses were more often associated with stage 1 hypertension than stage 2 as is observed for both ears which are statistically significant. The mean threshold of the hearing was 28.84±16.84 and 24.16±11.31 amongst stage 1 and stage 2 hypertensives respectively. There was no statistically significant alteration of the hearing status of the hypertensives on subsequent follow-up, baring 3 cases that showed some recovery on the last follow-up. Hypertension as compared to control cases has a statistically significant influence on the hearing status of subjects above 31 years of age. Present data show that they have only marginally raised threshold for speech frequencies and it is at 4 kHz and 8 kHz that they are most often affected with hypertension.

Keywords: Hearing loss, Hypertension, Pure Tone Audiometry, Sensorineural Hearing Loss.

1. INTRODUCTION

Hearing loss is a multifactorial malady that can be caused by a variety of things, including extended moderate social, mechanical, and ambient noise exposure, toxic material inhalation, ototoxic food or medications, and metabolic and circulatory changes. Infections, different sorts of injuries, and genetic inheritance may all contribute to hearing loss.

According to the American Speech-Language Hearing Association, there are currently 28 million people in the United States with some form of hearing loss, with 80 percent of them being permanently disabled [1].

In Nepal, there is evidence of an increasing trend in the prevalence of hypertension. The prevalence of hypertension was only 6% in the initial survey in 1982, but by 2007, it had risen to 33.8 percent. Hypertension had also been shown to be on the rise in both the rural and urban populations[2]. By affecting the vascular system, high blood pressure can produce inner ear bleeding and alter perfusion, resulting in progressive or sudden hearing loss[3]. Increased blood viscosity limits capillary blood flow and thus oxygen transfer, resulting in neuronal dysfunction and hearing loss in patients[4]. Furthermore, arterial hypertension can alter the ionic potentials of cells and inner ear fluids, resulting in hearing loss[5].The increased synthesis of elastin and collagen by smooth muscle cells, which contributes to the thickening of the artery wall, is one of the macrovascular alterations that occur in hypertension. It also undergoes hyperplasia in the media of the vessels[6]. If hypertension is left untreated for more than 7-10 years, around half of the hypertensive people experience end-organ damage[7]. The labyrinthine artery, a terminal branch of the vertebrobasilar system, supplies the cochlea with a single arterial blood supply. As a result, any compromise of the systemic and local circulation puts it at risk[8]. The acoustic or speech signal processing, and thus the individual's hearing capacity, may be affected by the systemic pathological circulatory condition in hypertension[9].

2. MATERIAL AND METHODS

The study was conducted on a sample of 100 subjects. 50 serial cases of hypertension were selected from the routine outpatient department of medicine and allocated into one group. 50 healthy subjects were selected who fulfilled the inclusion criteria in Nepalgunj Medical College from the time period 1st December 2014 to 30th January 2016. Patients with ages more than 50 years have presbycusis and less than 5 years, known cases of hypertension under antihypertensive drugs, family history of deafness or middle ear abnormality, excessive recreational or occupational noise exposure, ototoxic drug usage, severe head injury, chemotherapy, head or neck radiotherapy, autoimmune diseases, and any other co-morbidity affecting hearing were all excluded. The audiological evaluation was done with a tuning fork test, pure tone audiometry, and special tests of audiometry. Blood pressure level was estimated at the primary visit and 3 subsequent visits. Hypertensive patients were categorized as.

2.1 Statical Analysis

The data collected were tabulated and the results of the study were analyzed using the statistical package for social science (SPSS) 20.0 and Microsoft Word and Microsoft Excel were used to generate graphs, tables, etc. The significance level was assessed by calculating the p-value using Pearson's Chi-square test. Observations were taken as significant at p-value less than 0.05 ($p < 0.05$).

1. Category Normal	**Systolic BP** <120	**Diastolic BP** <80
2. Category Pre-HTN	**Systolic BP** 120-139	**Diastolic BP** 80-89
3. Stage 1 HTN	**Systolic BP** 140-159	**Diastolic BP** 90-99
4. Stage 2 HTN	**Systolic BP** >160	**Diastolic BP** >100

Follow-up Pure Tone Audiometry and other special audiological tests were done to study the effect of blood pressure level on the hearing status and to establish if there was an improvement in hearing with an improvement in the management of blood pressure. For assessing the hearing loss, the pure tone average was calculated and rated as.

- Normal Hearing < 25db
- Mild Hearing loss 25 - 40 dB
- Moderate Hearing loss 41 - 55 dB
- Moderately severe Hearing loss 56 - 70 dB
- Severe Hearing loss 71 - 90 dB
- Profound Hearing loss > 90 dB

3. RESULT

There was near-normal hearing in the right ear associated with hypertension in subjects younger than 31 years. Association of hearing loss appears to progress with rising age, but this contention however was not statistically significant ($p=0.19$). Similar observations were found for the left ear also amongst these hypertensive subjects and were not statistically significant ($p=0.118$). An element of pre-senile presbycusis perhaps is likely to add to the effect of hypertension in subjects above 45 years.

Table 1: Association of Hearing Loss in Rt. Ear with Age in Hypertensives

Rt. PTA	10-20	21-30	31-40	41-50	Total
Normal	2	7	13	15	37
Mild HL	0	0	1	3	4
Mod HL	0	0	0	2	2
Mod-severe HL	0	0	3	3	6
Severe HL	0	0	0	1	1
Total	2	7	17	24	50

Table 2: Association of Hearing Loss in Lt. Ear with Age in Hypertensives

Lt. PTA	10-20	21-30	31-40	41-50	Total
normal	2	7	12	14	35
mild HL	0	0	1	5	6
mod HL	0	0	0	4	4
mod-severe HL	0	0	4	1	5
Total	2	7	17	24	50

Table 3: Mode and Mean of Hearing Threshold in dB in Rt. Ear among different Age Groups in Hypertensives

Age group in years	Mode of Hearing threshold in dB	Range	Mean Hearing threshold in dB	SD	SD variance
<20	17	17-18	17.5	0.7	0.5
20-30	20	13-23	18.71	4.07	16.57
31-40	20	15-60	26.70	14.86	220.97
41-50	22	13-72	29.37	15.79	249.46

Table 4: Mode and Mean of Hearing Threshold in dB in Lt. Ear among different Age Groups in Hypertensives

Age group in years	Mode of Hearing threshold in dB	Range	Mean Hearing threshold in dB	SD	SD variance
<20	15	15-20	17.5	3.53	12.5
20-30	20	16-25	21	3.16	10
31-40	20	15-69	31.23	18.03	325.441
41-50	22	16-56	30.91	13.18	173.732

4. CORRELATION OF GRADE OF HEARING LOSS WITH THE GENDER OF HYPERTENSIVES

Contrary to the expectation of females being less prone to hypertension, in the present study the subjects were gender-matched. There was a higher prevalence of mild hearing loss in female subjects under study in both ears whereas males were more often affected by severe hearing loss. The observations were statistically insignificant (p= 0.299 and 0.324 for right and left ear respectively). The observations are shown in figure no. 15a and 15b below.

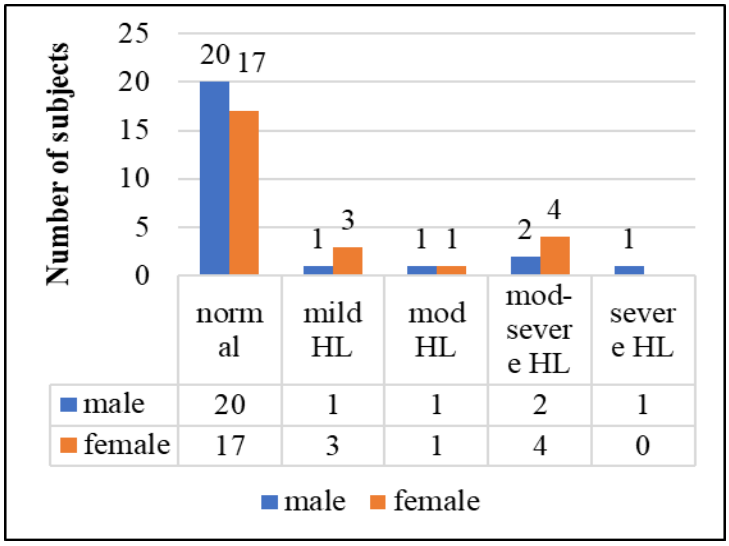

Figure 1: Correlation of Hearing Loss in Right Ear with Gender

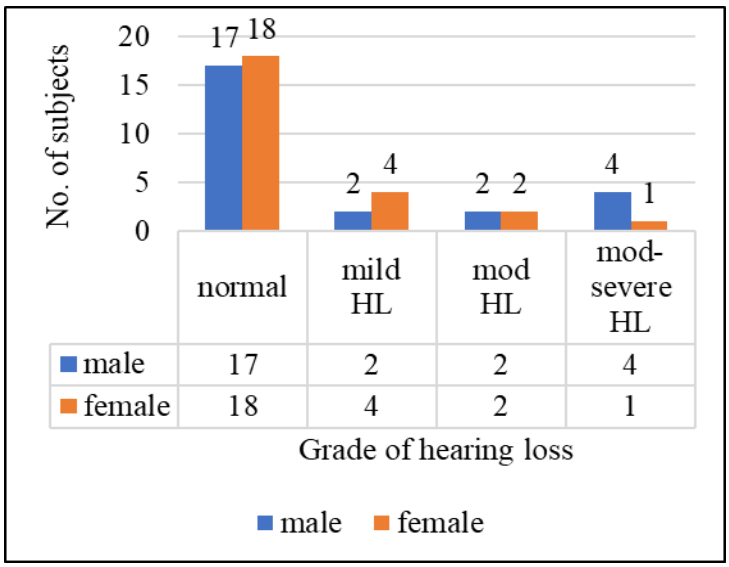

Figure 2: Correlation of Hearing Loss in Left Ear with Gender

Table 5: Mode and Mean of Hearing Threshold in dB in Rt. Ear among different Gender in Hypertensives

Gender	Mode of Hearing threshold in dB	Range	Mean Hearing threshold in dB	SD	SD variance
Female	20	13-60	27.32	13.957	194.81
Male	22	13-72	25.68	15.068	227.06

Table 6: Mode and Mean of Hearing Threshold in dB in Lt. Ear among different Gender in Hypertensives

Gender	Mode of Hearing threshold in dB	Range	Mean Hearing threshold in dB	SD	SD variance
Female	20	19-69	27.92	12.192	148.66
Male	24	15-61	30.28	16.48	271.793

The quantum of hearing loss showed that both moderately severe and severe hearing loss in the right ear was distinctly associated with stage 1 hypertension than stage 2. Observation on the left side also noted to have hearing loss more often associated with stage 1 hypertension as compared to stage 2 hypertension. Furthermore, moderately severe and severe hearing losses were also observed even in the left ear proportionately more with stage 1 hypertension. (P values are 0.05 for right and 0.009 for left ears). The existence of hearing loss was more often associated with stage 1 than stage 2, it is statistically significant.

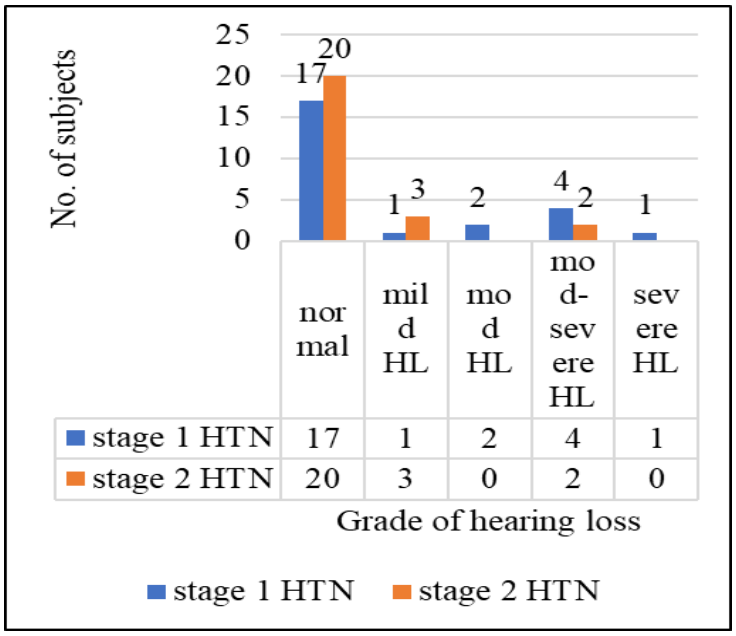

Figure 3: Correlation of Hearing Loss in Right Ear with Hypertensive Level

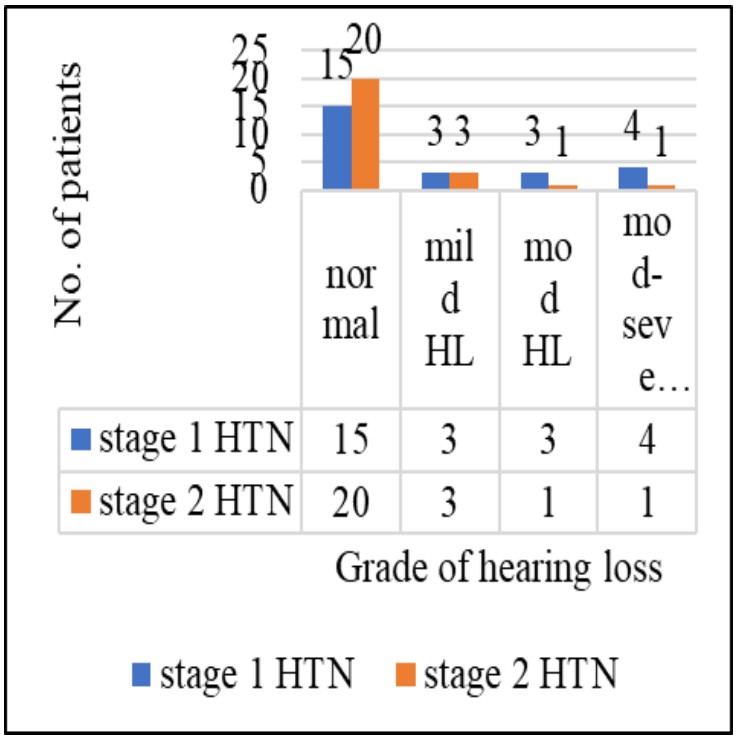

Figure 4: Correlation of Hearing Loss in Left Ear with Hypertensive Level

Observed on follow-up, the hypertension of stages 1 and 2 got progressively stabilized converting to the pre-hypertensive stage. The hearing status amongst stage 1 revealed no change in status of severe hearing loss on follow-up. The moderately severe and moderate loss was observed to be more or less the same on follow up baring 2 cases of moderately severe showed some recovery on the last follow-up (cases no. 12 and 25). It is statistically significant (p= 0.018). In 2 cases of stage 1 hypertension, on control of blood pressure, hearing loss became moderate loss from moderately severe (cases no. 4 and 25). Such fluctuation in hearing status is statistically significant (p= 0.035)

It appears that a rise in the threshold of hearing is a function of rising blood pressure but either the central or peripheral effect of it on the hearing system is already imposed during stage one of hypertension and is mostly irreversible. It only marginally worsens with hypertension rising to stage two as per present study subjects.

Table 7: Mode and Mean of Hearing Threshold in dB in Rt. Ear and its Correlation with Hypertensive Level

Hypertension	Mode of Hearing threshold in dB	Range	Mean Hearing threshold in dB	SD	SD variance
Stage One	20	13-72	28.84	16.84	283.80
Stage Two	20	13-60	24.16	11.31	128.05

Table 8: Mode and Mean of Hearing threshold in dB in Lt. Ear and its Correlation with Hypertensive Level

Hypertension	Mode of Hearing threshold in dB	Range	Mean Hearing threshold in dB	SD	SD variance
Stage One	19	15-61	32.2	16.15	261
Stage Two	20	15-69	26	11.93	142.33

Table 9: Hearing Thresholds of Rt. Ear and its Correlation with Hypertensive Levels in primary and Subsequent Visits

First Visit (N=50)		**1st F/U (duration of 1 to 3 months) (N=50)**		**2nd F/U (Duration of 1 to 2 months) (N=50)**		**3rd F/U (Duration of 1 to 3 months) (N=50)**	
Range of BP	Type of hearing loss	Range of BP	Type of hearing loss	Range of BP	Type of hearing loss	Range of BP	Type of hearing loss
Stage 1 (N=25)	Normal=17	Pre- HTN (N=33)	Normal=26	Normal (N=1)	Normal=1	Normal (N=3)	Normal=3
	Mild=1		Mild=3	Pre-HTN (N=42)	Normal =32	Pre-HTN (N=43)	Normal =32
	Moderate=2		Moderate=1		Mild=3		Mild=3
	Moderate-severe=4		Moderate-severe=2		Moderate=2		Moderate=4
	Severe=1		Severe=1		Moderate-severe=4		Moderate-severe=3
Stage 2 (N=25)	Normal=20	Stage 1 (N=17)	Normal=11		Severe=1		Severe=1
	Mild=3		Mild=1	Stage 1 (N=7)	Normal =4	Stage 1 (N=3)	Normal=2
	Moderate=0		Moderate=4		Mild=0		Mild=1
	Moderate-severe=2		Moderate-severe=1		Moderate=2	Stage 2 (N=1)	Moderate-severe=1
	Severe=0		Severe=0		Moderate-severe=1		

Table 10: Hearing Thresholds of Lt. Ear and its Correlation with Hypertensive Levels in Primary and Subsequent Visits

First Visit (N=50)		**1st F/U (N=50)**		**2nd F/U (N=50)**		**3rd F/U (N=50)**	
Range of BP	Type of hearing loss	Range of BP	Type of hearing loss	Range of BP	Type of hearing loss	Range of BP	Type of hearing loss
Stage1 (N=25)	Normal=15	Pre –HTN (N=33)	Normal=23	Normal=1	Normal=1	Normal (N=3)	Normal=3
	Mild=3		Mild=2	Pre-HTN (N=42)	Normal=31	Pre-HTN (N=43)	Normal=30
	Moderate=3		Moderate=6		Mild=4		Mild=5
	Moderate-severe=4		Moderate-severe=2		Moderate=5		Moderate=6
	Severe=0		Severe=0		Moderate-severe=2		Moderate-severe=2
Stage2 (N=25)	Normal=20	Stage1 (N=17)	Normal=12	Stage1 (N=7)	Normal=3	Stage 1 (N=4)	Normal=2
	Mild=3		Mild=3		Mild=1		Mild=1
	Moderate=1		Moderate=2		Moderate=2		Moderate-severe=1
	Moderate-severe=1		Moderate-severe=0		Moderate-severe=1		

5. DISCUSSION

The prevalence of hypertension is unusual in younger subjects hence maximum cases were observed above 31 years of age. The observations of ASHA have reported that 4.6% of the individuals between 18 and 44 years of age have a hearing loss while 14% of the middle-aged individuals between 45 and 64 years and 54% of the population above 65 years have some hearing loss therefore, perhaps the compromise in hearing acuity observed in the subject under study may not be due to aging factor alone. Hypertension causing hearing disorder was also confirmed by Markova (1990). In his study of cochleovestibular syndrome on 50 hypertensives, it was found that 47 subjects had bilateral and 3 subjects with unilateral hearing disorders[10]. Capoani et al. conducting a retrospective study of both genders found that there was a significant association between hypertension and hearing loss[11]. De Moraes Marchiori et al. has also found a similar association between hypertension and hearing loss[12]. Kamlesh Sharma et al. in their study in 2015 adults analyzed that there was no significant difference in hearing thresholds at various frequencies between hypertensive and normotensive groups and between uncontrolled and controlled hypertensive subgroups. However, a significantly positive correlation between the systolic blood pressure and Air conduction thresholds at 4000 Hz (p= 0.007) and 8000Hz (p= 0.012) and Bone conduction thresholds at 4000 Hz (p= 0.005) were noted in the uncontrolled hypertensive subgroup. Results of the study demonstrated the potentially negative impact of uncontrolled hypertension on auditory function in the age group of 40-60 years[13]. In our study the threshold in the left ear was normal in 35 Ears in hypertensives and 46 Ears in controls. So also, in right ear threshold was within normal limits in 37 Ears in hypertensives and 46 in controls. Although the threshold was raised in 16 cases, it revealed only mild loss in 10 Ears (6 left and 4 right) amongst hypertensives. In the present series of cases also it is observed that hypertensives have only marginally increased threshold for speech frequencies (0.5 kHz to 2 kHz). It indicates that it is 4 kHz and 8 kHz that are the most affected frequencies in cases of hypertension. This observation is in agreement with Sharma et al. (2015).

Tan et al. (2009) found that the threshold was high in all the frequencies on both sides in the hypertensive subjects. However, it was found to be statistically significant ($p < 0.05$) at 2,000 Hz, 4,000 Hz, and 8,000 Hz only[14]. These observations are in agreement with finding in the present series of cases also.

Baraldi et al. (2004) studied hearing loss and hypertension in seventy people of age group from 60 to 92 evaluated through anamnesis and threshold tonal audiometry and did not find a correlation between hearing loss and hypertension and audiological data were similar to those with normal pressure subjects. This they claimed was due to age-related changes are equally effective as are the effects of hypertension on hearing impairment[15]. In disagreement with them in the present study statistically significant difference with controls is observed in hypertensive subjects and it overrules the aging being the main factor of raised threshold in hypertensive subjects.

In follow up of these cases the pathological effect of hypertension on hearing is observed to be persisting more or less unchanged despite control of tension and therefore it is possible to conclude that the effect of raised tension may be only mild in hearing frequency. Hence despite reduced stress and hypertension, the hearing loss is not expected to be reversed except when hypertension-induced ischemia is likely to be the cause of transient hydrops of the labyrinth.

6. CONCLUSION

Most of the hypertensive patients were observed 31-50 year's group and the association of hearing loss appeared to progress with rising age i.e., none of the patients in less than 30 years followed by 5 (10%) patients in 31-40 and 10 (20%) patients in 41-50 years' group. There were 25 (50%) stage 1 hypertensives that had their blood pressure ranging from 140 to 159 systolic and 90 to 99 diastolic and other 25 (50%) stage 2 hypertensives ranged from 160 to 200 systolic and 100 to 140 diastolic. Hypertension as compared to control cases had a statistically significant effect on the hearing status of the subjects. There were 16 cases having sensorineural hearing loss in 28 ears (13 Rt. Ears and 15 Lt. Ears) amongst hypertensives which were statistically significant. In the present study, it was observed that hypertensives have only marginally increased threshold in Rt. Ear for speech frequencies mode being 20 dB and mean hearing threshold being 26.3±14.64. It was at 4 kHz and 8 kHz that they were the most affected modes being 20 dB and 25 dB respectively, with mean hearing thresholds 29.8±19.37 and 34.2±19.85 respectively. Similarly, Lt. Ear's mode of the hearing threshold being 20 dB in speech frequencies and high-frequency tones. The mean hearing threshold for speech frequencies was 26.73±13.87, at 4 kHz and 8 kHz it was 31±17.14 and 33.6±17.52. In the present series, the correlation of grade of hearing loss with hypertensive level showed that both moderately severe and severe hearing losses were more often associated with stage 1 hypertension than stage 2 in both ears which was statistically significant. The mean hearing threshold was 28.84±16.84 and 24.16±11.31 amongst stage 1 and stage 2 hypertensives respectively. On subsequent follow-ups, 46 (92%) subjects were normalized converting to pre-HTN and to normal

blood pressure. The hearing status but amongst stage 1 and stage 2 revealed no change which was statistically significant. Only 3 cases showed some marginal recovery on the last follow-up. This fluctuation in hearing status is statistically significant (p-value for Rt. Ear and Lt. ear =0.018 and 0.03).

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