



STUDY OF HEARING LOSS IN CEREBROVASCULAR ACCIDENTS OR STROKE PATIENTS WITH PURE TONE AUDIOMETRY - AN OBSERVATIONAL STUDY

Dr. Ashok Murthy
V.

ABSTRACT Stroke is one of the leading cause of disability in elderly patients in life style disease category. The sequela of stroke covers all aspects of daily activities, leading to miserable quality of life. **Aim:** To study hearing impairment among patients of cerebrovascular accidents using pure tone audiometry. **Materials and Methods:** The individuals affected by stroke are assessed for hearing loss after recovery from the cerebrovascular accident during their visit to the hospital. A questionnaire was prepared and details regarding smoking, hypertension, alcohol intake, medical documents when discharged, radiological details of the lesion and other relevant details pertaining to the study was compiled and analysed. These patients were subjected to undergo pure tone audiometry and hearing threshold was noted. **Results:** CT scan of the brain showed a maximum of 70% had hemispheric infarction; 58% had a stroke on the right side, and 42% had a stroke on the left side. 60% had a history of smoking; 98% had a history of hypertension and 20% had diabetes mellitus. Among the study participants who had right sided stroke, maximum of 28% presented with right sided mild SNHL and left sided stroke maximum of 18% presented with left sided moderate SNHL. **Conclusion:** Cerebrovascular accidents / stroke do cause hearing loss. Most of the patients go undiagnosed or undetected. These patients should be put under routine protocol of hearing evaluation, so recovery of speech and hearing is addressed and quality of life is not compromised.

KEYWORDS :

INTRODUCTION

Non-communicable diseases(NCD) are also known as chronic diseases as they tend to be of long duration due to genetic, physiological, environmental and behavioral factors. The main types of NCD are cardiovascular and cerebrovascular diseases like heart attacks and strokes, cancers, respiratory diseases, diabetes, hypertension etc. [1] Stroke, as such, is a medical condition in which poor blood flow to the brain causes cell death. [2] There are two types of stroke, mainly ischemic due to lack of blood flow and hemorrhagic due to bleeding, which causes parts of the brain to stop functioning correctly with various symptoms like paralysis, difficult speech, loss of vision, and dizziness.[3] Another symptom that many are unaware of is hearing loss.[4] Stroke is a leading cause of neurological disability. Every third of stroke survivors are functionally dependent on others 1 year after stroke onset.[5]Stroke can affect all levels of the auditory pathway from the hearing organ to the cortex and manifest with deficits in audiometric thresholds and complex central auditory processing disorder (CAPD) with perceptual difficulties in speech, sound recognition and localisation.[6][7] Most stroke survivors need rehabilitation (8), as hearing impairment increases the risk of decreased physical fitness after discharge, this can be due to restricted participation in post-acute rehabilitation programs due to hearing impairment(9). It is also known that uncorrected hearing loss leads to isolation, reduced social activity and quality of life. Hence this study is selected to know about hearing loss in stroke patients and to classify the hearing impairment using detailed audiological assessment to determine the level of hearing loss and bring awareness among the patients about the importance of appropriate rehabilitation to this set population with hearing impairment so that there can be an improvement in the quality of life.

Significance Of This Study

Not many studies have been done on the hearing loss in stroke patients in India. Hence, a hospital-based study has been carried out at the PES Institute of Medical Sciences & Research (PESIMSR), Kuppam, to learn about hearing loss in stroke- affected patients. The ultimate purpose of the study is to generate information on hearing loss that may help frame policy to guide public health prevention initiatives against neglected hearing loss in stroke-affected patients.

AIMS & OBJECTIVES:

Aim:

To study hearing impairment among patients of cerebrovascular accidents using pure tone audiometry.

Objectives:

- 1) To study the type and site of lesion affecting the hearing among these patients.
- 2) To assess hearing loss among these cerebrovascular accident patients using pure tone audiometry.

MATERIAL AND METHODS

Study Area: The Present study was conducted in ENT, PES Institute of Medical Sciences & Research (PESIMSR), Kuppam, Andhra Pradesh, India.

Study Design: Hospital-based Cross-sectional study.

Study Participants: Individuals aged above 20 years up to 80 years.

Inclusion Criteria:

1. Patients aged 20 years and above up to 80 yrs.
2. Clinical history of stroke, which is verified by magnetic resonance imaging (MRI) of the brain
3. Patients who have given written informed consent.
4. Patients who came with complaints of hearing loss.

Exclusion Criteria:

1. Severe aphasia.
2. Cognitive impairment as shown on the Montreal cognitive assessment (MoCA) with a score <25.
3. Significant psychiatric illness.
4. Other neurological disorders except for stroke.
5. Severe concurrent uncontrolled medical illnesses.
6. Patients with a previous history of hearing loss before the onset of stroke.
7. Patients who have not given consent.
8. Devastated and debilitated persons (mental illness, physical disability, medical illness).
9. Patients aged less than 20 years and above 80 years.

Sample Size: 50

In this study, a total of 50 patients affected with stroke have been included by convenient sampling method

Sources of Data

There were 2 sources of data collected. First was the response from the subjects during the interview, and second, were the records of their own available.

Tools for Data Collection

After a systematic review of published studies, a questionnaire was designed for data collection. The questionnaire was validated after incorporating the received inputs; the questionnaire was pilot-tested, and further modifications were done. The questionnaire was initially designed in English and then translated into the local language (Telugu) with the help of a translator.

RESULTS

Table no 1: Distribution of Participants According to CT Brain Findings:

CT Findings	Frequency	Percentage
Hemispheric infarction	35	70%
Brain stem infarction	7	14%
Cerebellar infarction	3	6%

Multiple sites	5	10%
Total	50	100%

Among the study participants on CT scan of the brain showed a maximum of 70% had hemispheric infarction; 14% had brain stem infarction, 10% had it on multiple sites, and 6% had cerebellar infarction.

Table no 2: Distribution According to the Side of Stroke:

Side of stroke	Frequency	Percentage
Right	29	58%
Left	21	42%
Total	50	100%

Among the study participants, 58% had a stroke on the right side, and 42% had a stroke on the left side

Table no 3: Distribution According to the Side of Stroke and Type of Hearing Loss

Side of stroke	Same side of hearing loss				Total	P Value
	Minimal SNHL	Mild SNHL	Moderate SNHL	Mod severe SNHL		
Right side	2(4%)	14(28%)	10(20%)	3(6%)	29(58%)	0.001
Left side	1(2%)	7(14%)	9(18%)	4(8%)	21(42%)	
Total	3(6%)	21(42%)	19(38%)	7(14%)	50(100%)	

Among the study participants who had right sided stroke, maximum of 28% presented with right sided mild SNHL followed by 20% with right sided moderate SNHL, 6% with moderately severe SNHL and only 4% presented with minimal right sided SNHL.

In the study participants with left sided stroke maximum of 18% presented with left sided Moderate SNHL followed by 14% with left sided mild SNHL, and 8% presented with moderately severe SNHL and only 2% presented with minimal SNHL on left side and the difference was found to be highly significant as the P value is 0.001.

This observation shows that right sided stroke patients have relatively more incidence of hearing loss compared to left sided stroke.

Table No 4: Distribution of Participants According to History of Smoking:

Smoking	Frequency	Percentage
Yes	30	60%
No	20	40%
Total	50	100%

Among the study participants maximum of 60% had a history of smoking

Table No 5: Distribution of Study Participants According to the History of Hypertension.

Hypertension	Percentage	Percentage
Yes	49	98%
No	1	2%
Total	50	100%

Among the study participants, 98% had a history of hypertension

Table no 6: Distribution of Study Participants According to the History of Diabetes

Diabetes	Frequency	Percentage
Yes	10	20%
No	40	80%
Total	50	100%

Among the Study Participants, 20% had Diabetes Mellitus

Review Of Literature

Definition and Description of Cerebrovascular Diseases:

Stroke is defined as "rapidly developing clinical indicators of localised or global disruption of cerebral function with symptoms lasting for a day or more resulting to death with no evident cause other than that of vascular origin" by the World Health Organization (WHO). (10) By applying this definition, transient ischemic attack (TIA) is defined to last less than 24 hours.

Various Studies on Hearing Loss Among Stroke Patients:

Sharma, Suktara et al.[11] 2021 studied hearing impairment in stroke patients. They performed pure tone audiometry within 15 days of the

stroke and found mean hearing loss. The mean audiometric threshold was significantly higher in both ears in stroke patients (mean-44.0±12.1db). Sensorineural hearing loss was more common in stroke-affected patients, and most ischemic strokes involved the middle cerebral artery. From this study, they concluded that undetected hearing loss might impact post-stroke functional recovery. Hence, current rehabilitation guidelines should include hearing screening in all stroke patients to detect hearing loss.

Wang XL et al.[12] 2021 had a case report of cerebellar artery infarction with sudden hearing loss and vertigo as initial symptoms; they studied a 48year old male patient and found out that the patient had come with complaints of sudden hearing loss and vertigo and on the detailed investigation, it was found there was cerebral infarction that was supplied in the territory of AICA and PICA. The patient was followed up for three months and showed complete hearing recovery when proper treatment and rehabilitation services were provided.

Nicci Campbell et al.[13], in 2019 in their study on hearing impairment after subarachnoid hemorrhage, found that 23% of SAH patients reported hearing difficulty that was new in onset post SAH. They also had a poorer pure tone threshold that was new in onset; they have concluded that neurovascular teams should inquire about hearing and refer SAH patients for audiological assessment and management.

Koohi et al[14] in 2016 did a study on hearing characteristics in stroke patients wherein Pure tone audiometry was undergone by all patients and another test like auditory evoked brain stem response as well; as they found that overall mean hearing thresholds were not significantly different between control and stroke groups. However, the most common type of hearing loss was peripheral and central in the 61-80years subgroup and auditory processing deficits in 18-60years that is 40% which was significantly higher.

Onoue et al.[15], in 2014, studied audiological findings in 43 aphasic patients after stroke and found that 78.6% had sensorineural hearing loss. In addition, speech recognition and word recognition scores were not obtained in some patients because they could not perform the task. Goyal et al.[16] 2010 reported a case of central pontine haemorrhage due to capillary telangiectasia who had bilateral hearing loss but normal ABR. The hearing loss had resolved six months later. The authors proposed that the hearing deficit was due to disruption of the ventral acoustic striae that decussate in the trapezoid body. Hearing loss may also occur due to a stroke of higher-level subcortical structures.

DISCUSSION

The present dissertation titled "STUDY OF HEARING LOSS IN CEREBROVASCULAR ACCIDENTS OR STROKE PATIENTS WITH PURE TONE AUDIOMETRY- AN OBSERVATIONAL STUDY." will throw light on hearing aspects in stroke patients. It can be useful to know the level of disability faced by patients due to hearing loss which when diagnosed earlier can help them recover early provided proper rehabilitation measures taken with the help of occupational therapist, audiologist and the quality of life is improved. The anatomy of the ear and the auditory cortex are connected by a complicated system that transmits an auditory signal from one to the other, allowing for the perception and identification of sound. The quality of life is significantly impacted by hearing abnormalities, which can lead to neurological conditions that can be fatal. When a patient has a brain stroke, auditory dysfunction is sometimes hidden by other neurological issues, making evaluation challenging. The most common neurological condition that produces various types of auditory impairment is cerebral vascular disease (CVD). Ours is a hospital based cross-sectional study done to know the status of hearing in cerebrovascular patients with the help of pure tone audiometric measurements. According to socio-demographic characteristics: When we look at the participants age, it was found that the mean age was 55.18±10.06 years with maximum age was found to be 70 years and the lowest age was 39years. The maximum percentage of patients were seen in age group of 61- 70years. In our study, maximum of 68% were males and only 32% were females. Among this age group maximum of 24% were males and only 12% were females and the difference was not found to be significant as P value is 0.8.

According to LiangleYang et al in 2022 a study was done on hearing loss is associated with increased risk of stroke and found that the mean age group in this study was found to be 63.3years.[17]

Kuo et al in 2016 studied risk of sudden sensorineural hearing loss in

stroke patients. They found that maximum of 51.3% patients with stroke are in 60-79 age group followed by 30.8% in the age group of 40-59 years followed by 12.3% above 80years and only 5.6% were in 18-39years.[18]

Koochi et al in their study done in 2016 found that the mean age was 58.19±15.06 years and maximum age were between the age group of 61-80years which was similar to our study and also males were found to be 78% and only 22% were females which was almost similar to our study.[14]

Bamiou et al in their study found that mean age was 61years in case group and out of which maximum of 7.4% were males and only 28.5% were females.[7]

According to Co-morbidities:

According to our study it was found that maximum of 98% had hypertension, 60% had history of smoking, only 20% had history of diabetes, 30% had history of alcohol consumption.

Kuo et al in their study found that 81.8% had history of hypertension which is similar to our study, maximum of 50% had history of diabetes which was comparatively more than our study and also 52.5% had history of hyperlipidaemia.[18].

Sharma et al found that after adjusting for Diabetes mellitus and hypertension, sensorineural hearing loss was more common and severe in stroke patients compared to controls.[11]

Hankey G J found that smoking raised the risk of stroke which contributed to hearing loss [19]

According to History of Stroke.

According to our study it was found that maximum of 70% had hemispheric infarction on CT followed by 14% had brainstem infarction, 10% had changes in multiple sites and only 6% had cerebellar infarction and also when side of stroke was considered, it was found that 58% had right sided stroke and only 42% had left sided stroke.

Kuo et al in their study found that maximum patients had ischemic stroke followed by haemorrhagic stroke.[18]

Lee et al studied Cerebellar infarction can produce a unique stroke syndrome in which it's typically accompanied by unilateral hearing loss, which can easily go unnoticed by patients. The low percentage of vertigo due to infarction involving the superior cerebellar artery distribution can be a useful way of distinguishing clinically from PICA or AICA cerebellar infarction in patients with acute vertigo and limb ataxia.[20]

According to Findings of Pure Tone Audiometry:

According to our study it was found that in the right ear- low frequency and mid frequencies showed maximum of 28% were with mild sensorineural hearing loss followed by 20% showed moderately sensorineural hearing loss. When high frequencies were checked in right ear- maximum showed mild sensorineural hearing loss followed by moderate sensorineural hearing loss.

When the left ear was studied it was found that low and mid frequencies showed mild and moderate sensorineural hearing loss though 50% of the patients it could not be appreciated. In our study it was found that hearing loss on affected side showed a maximum of 18% was moderate sensorineural hearing loss followed by mild sensorineural hearing loss (14%) and least were with minimal hearing loss (2%) hearing loss. On unaffected side hearing loss was seen in 58% of patients. Moderate hearing loss in 10%, minimal hearing loss in only 8%, and 40% patients had hearing within normal limits.

Landi F et al in their study found that 41.5% of participants had mild hearing loss and 23.5% of participants had moderate hearing loss and only 2% had severe or more hearing loss which was in contrast to our study. When the follow-up was done 23 out of 46 participants who had hearing loss declined ENT follow-up when the reasons were asked it was found to be either mild hearing loss or would feel to focus more on other health related problems this was may be because of poor awareness of hearing loss among patients.[21]

Edwards et al in their study found that mild hearing loss was seen in

40% patients, moderate hearing loss seen in 15% patients, 8% showed moderately- severe hearing loss, 1% showed severe hearing loss and around 36% had normal hearing which was near to our study.[22]

SUMMARY & CONCLUSIONS

The present study on "STUDY OF HEARING LOSS IN CEREBROVASCULAR ACCIDENTS OR STROKE PATIENTS WITH PURE TONE AUDIOMETRY-AN OBSERVATIONAL STUDY." involved 50 participants studied for a period of 2 years from September 2020 to Sept 2022.

1. Among study participants maximum of 36% were between 61-70 years of age and minimum of 12% were among 31-40 years of age group and the mean age is 55.18±10.06 years and the minimum age found was 39 years and the maximum age of patient was found to be 70 years.
2. Among the study participants maximum of 68% were Males and 32% were Females.
3. Among study participants maximum of 24% were males seen in age group of 61-70 years and maximum of 12% are females seen in same age group and the difference is not significant as the P-Value is 0.7
4. Among the study participants maximum of 60% has history of smoking and 98% had history of hypertension and 80% did not have any history of diabetes.
5. On CT brain imaging 70% had hemispheric infarction followed by 14% brain stem infarction and 10% has history of infarction at multiple sites and only 6% had cerebellar infarction.
6. According to the side of stroke maximum of 58% had stroke on right side and only 42% had stroke on left side.
7. Among the study participants who had right sided stroke, maximum of 28% presented with right sided mild SNHL followed by 20% with right sided moderate SNHL, 6% with moderately severe SNHL and only 4% presented with minimal right sided SNHL.
8. Among patients with left sided stroke, maximum of 18% presented with left sided moderate sensory neural hearing loss followed by 14% mild SNHL, 8% presented with moderate severe SNHL and only 2% had minimal SNHL and the difference between them is not found significant as P value is 0.6.
9. And 30 patients in the study are having bilateral hearing loss irrespective of side of the stroke which may be minimal/mild/moderate/moderately severe hearing loss. This is because of the prolonged duration of stroke, presbycusis.

Recommendations

1. A proper follow-up of patients is required who have suffered stroke. Among the study participants maximum of 60% had history of smoking and 98% had history of hypertension and 80% did not have any history of diabetes.
2. Health workers are to be sensitized of hearing Impairment in stroke patients so that appropriate measures are taken to restore hearing. It can be done by conducting Continued Medical Education, Workshops for health Care Providers and explaining them the importance of Screening for Hearing Loss In Stroke Patients.

Limitations of the Study

- 1) The main limitations of the study was sample size which is small and the results cannot be generalised.
- 2) PTA is sensitive more to Peripheral Hearing and unable to rule out more of Central Auditory Dysfunction.

REFERENCES

1. Noncommunicable diseases (who.int) 13 April 2021.
2. www.nhlbi.nih.gov/. March 26, 2014. Archived from the original on 18 February 2015.
3. Donnan GA, Fisher M, Macleod M, Davis SM. "Stroke". Lancet. May 2008; 371 (9624): 1612-23.
4. "What Are the Signs and Symptoms of a Stroke?". www.nhlbi.nih.gov. March 26, 2014.
5. Murray CJ, Lopez AD. Evidence-based health policy: lessons from the Global Burden of Disease Study. Science 1996; 274:740-743.
6. Bamiou D-E. Hearing disorders in stroke. Handb Clin Neurol. 2015; 129:633-47.
7. Bamiou DE, Werring D, Cox K, Stevens J, Musiek FE, Brown MM, et al. Patient-reported auditory dysfunctions after stroke of the central auditory pathway. Stroke. 2012; 43:1285-9.
8. MacDonald BK, Cockerell OC, Sander JW. The incidence and lifetime prevalence of neurological disorders in a prospective community-based study in the UK. Brain: a journal of neurology. 2000; 123 :665-76.
9. Landi F, Onder G, Cesari M. Functional decline in frail community-dwelling stroke patients. European journal of neurology: the official journal of the European Federation of Neurological Societies. 2006; 13: 17-23.
10. WHO MONICA Project Investigators. The World Health Organization MONICA Project (Monitoring trends and determinants in cardiovascular disease). J Clin Epidemiol 41, 105-114, 1988.
11. Sharma, Suktara et al, Hearing Impairment in Stroke Patients- Findings from a Pilot Study Conducted in India. Indian Journal of Otolaryngology & Head & Neck Surgery. Feb 2021, p1-7.
12. Wang XL, Sun M, Wang XP. Cerebellar artery infarction with sudden hearing loss and vertigo as initial symptoms: A case report. World J Clin Cases 2021; 9(11): 2519-2523
13. Nicci Campbell, Carl Verchuur et al. Hearing impairment after subarachnoid hemorrhage. Annals of Clinical and Translational Neurology. 2019; 6(3): 420-430.
14. Koochi N, Vickers DA et al. Hearing Characteristics of Stroke Patients: Prevalence and Characteristics of Hearing 5 Impairment and Auditory Processing Disorders in Stroke Patients. Journal of the American Academy of Audiology. 2016; 15(7).
15. Onoue SS, Ortiz KZ, Minett TS, Borges AC. Audiological findings in aphasic patients after stroke. Einstein (Sao Paulo). 2014 Oct-Dec; 12(4):433-9.
16. Goyal, M.K., Kumar, G., & Sahota, P.K. Reversible sensorineural hearing loss with normal brainstem auditory evoked potentials in pontine hemorrhage due to capillary telangiectasia. Journal of clinical neuroscience: official journal of the Neurosurgical Society of Australasia. 2010; 17(9): 1198-201.
17. Liangle Yang, Qin Fang et al, Hearing loss is associated with increased risk of incident stroke but not coronary heart disease among middle-aged and older Chinese adults: the Dongfeng-Tongji cohort study. Environmental Science and Pollution Research, 2022 volume 29, pages 21198-21209.

18. Kuo et al. Risk of sudden sensorineural hearing loss in stroke patients. *Medicine*;2016; 95:36
19. Hankey GJ. "Smoking and risk of stroke". *Journal of Cardiovascular Risk*. August 1999; 6 (4): 207–11.
20. Lee, H., Sohn, S.I., Jung, D.K., Cho, Y.W., Lim, J.G., Yi, S.D., et al. Sudden deafness and anterior inferior cerebellar artery infarction. *Stroke; a journal of cerebral circulation*, 2002;33(12), 2807-12.
21. Landi F, Onder G, Cesari M, Zamboni V, Russo A, Barillaro C, et al. Functional decline in frail community-dwelling stroke patients. *Eur J Neurol*. (2006) 13:17–23. doi: 10.1111/j.1468-1331.2006.01116.x
22. Edwards, D. F., Hahn, M. G., Baum, C. M., Perlmuter, M. S., Sheedy, C., & Dromerick, A. W. (2006). Screening patients with stroke for rehabilitation needs: validation of the post-stroke rehabilitation guidelines. [Research Support, Non-U.S. Gov't Validation Studies]. *Neurorehabil Neural Repair*, 20(1), 42-48. doi: 10.1177/1545968305283038