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## Research Article

# THE EFFECT OF DIGITAL AND ANALOG HEARING AIDS IN THE MANAGEMENT OF TINNITUS NOISE EFFECT - A COMPARATIVE STUDY

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### ABSTRACT

The effect of Tinnitus noise in a individuals ear is a very cumbersome. It affects in patients suffering from hearing loss. Tinnitus a squeaky or flat sound which occurs internally without any external stimulation or any external sound exposure. It occurs after a sudden or a continuous exposure to a very high intensity sound, due to ototoxicity, Noise exposure and aging. There are various treatments for Tinnitus to improve their quality of life. One of them is being use of amplification devices. Hearing aids were used both for masking and hearing.

This study is to compare which type of hearing aid (Digital or Analog) gives a better performance in reducing tinnitus respectively. A total of 40 participants within the age range of 16-75 years have been considered, all of them had undergone the routine audiological procedure and was diagnosed across mild-severe sensori-neural hearing loss. 20 participants have been prescribed with digital hearing aids while 20 have been prescribed with analog hearing aids. Tinnitus Handicap Inventory (THI) had been administered. Analysis on users of before hearing aid application and after use of hearing aid for 6 months and changes were done. Results shown significant difference when compared across pre and post for both the groups respectively and No significant difference when compared across the two populations.

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### INTRODUCTION

As per International Classification of Function, Disability and Health (ICF 2001) tinnitus is coded as a separate condition and is defined as a sensation of low-pitched rushing, hissing, or ringing in the ears. Its prevalence increases with age (Ahmad and Seidman, 2004). Tinnitus has been found to affect more in men than in women (Lockwood *et al.*, 2002). Nearly 1/4<sup>th</sup> of patients with tinnitus report an increase in severity over time (Stouffer and Tyler, 1990). A population-based study of adults with hearing loss in age group of 48 to 92 found 8.2 percent of tinnitus at base line and an incidence of 5.7% during a 5-year follow-up (Nondahl, Cruickshanks, Wiley, Klein, Klein, Tweed, 2002). It is said that approximately 17% of the world population is troubled by tinnitus and it has severe manifestation in 20% of cases. Presently the tinnitus is perceived as a consequence of modified neural activity in the central auditory system due to a peripheral damage in the auditory structures. According to Jastreboff in the year 1990

postulated that when the cochlea is damaged due to excessive noise, or drugs exposure or viral infections the outer hair cells (OHC) are damaged first and inner hair cells (IHC) later. IHC provide sound transduction while OHC amplification of sounds within the cochlea. Cochlear damage due to acoustic trauma changes the spontaneous firing rates of neurons in the dorsal cochlear nucleus (DCN) and hyperactivity can be observed in the DCN.

Over the years several treatment options have been developed for reducing the effects of tinnitus on psychological and health aspects of individuals and further improve their quality of life. Surgical therapy such as cochlear implant (CI) which is the standard treatment for the patients with severe to profound bilateral hearing loss. CI have been noted to reduce tinnitus in some patients and there was a positive effect of the reorganization of the central auditory nervous system after restoration of peripheral sensory input. There are certain disadvantages of CI in some patients tinnitus developed for the

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first time after the CI has been implanted and the higher cost of this equipment.

The hearing aids are being used as a device for tinnitus management since 60 years (Saltzman & Ersner, 1947). Melin *et al*, 1987 suggested that hearing aids provide little more benefit than counseling alone. In addition to that the hearing aids were recommended for many decades as a first approach to tinnitus sufferers with hearing impairment (Seldrake & Jastreboff, 2004 Searchfield, 2006). High proportion of hearing professionals see hearing aid as their primary tinnitus treatment strategy (Kochkin & Tyler, 2008).

Most tinnitus patients stated that their tinnitus is particularly bothersome when they are in silence and many patients develop strategies to decrease this experience by using every day sound sources (ex. TV, radio, music, Fan). For the same reason many health professionals' advice subjects to enrich background sounds and avoids quiet places. It is known that the majority of people affected by tinnitus have some degree of hearing loss (Jastreboff & Hazel 2004). Obviously hearing aids can help in the process, by providing an amplification of background sound level and expanding the utilized frequency range. As such, hearing aids are used as a tool to enhance further the stimulation of the auditory system and not for communication purposes only.

Our present study focuses on effectiveness of body level analog hearing aids and digital hearing aids on management of tinnitus and which of the models showed better performance in the inhibition of tinnitus and providing relief to the patients or to study the impact and compare the different hearing aid technologies (Analog and Digital) in the management of tinnitus with sensorineural hearing loss.

### **Objectives**

The objective of the study was to find the efficacy of the hearing aids with different technologies in the tinnitus management of the patients suffering with hearing loss. This study was carried by comparing and evaluating the responses of the patients who are using different hearing aids. This evaluation has been done in following objectives.

- To study the impact of analog hearing aids on patients suffering with tinnitus and hearing loss.
- To study the impact of digital hearing aids on patients suffering with tinnitus and hearing loss.
- To compare the responses on THI between the patients using analog hearing aids, digital hearing aids.

## **METHOD**

### **Sample**

The test was conducted on total of forty participants comprising twenty in each group with mild to moderate sensori-neural hearing loss with tinnitus. Patients were selected from those reporting to SRC, AYJNIHH clinical facility and others clinics in twin cities of Hyderabad & Secunderabad.

### **Selection of sample**

#### **Inclusion criteria**

- Patients with hearing loss and tinnitus certified by a qualified audiologist and attending AYJNIHH SRC/hospitals/clinics at Secunderabad.
- Patients having mild to moderate degree sensorineural hearing loss.
- Age range of the patients should be from 16 to 80 years of both gender

#### **Exclusion criteria**

- Patients with outer and or middle ear disorder and patients with profound hearing loss.
- Patients who were suffering with chronic and other diseases such as neurological disorders etc.
- Patients who were attending any other management/treatment.
- Patients having less than mild THI severity.

#### **Variables**

Dependent variables are age, sex, Hearing loss and Tinnitus severity/THI scores. However the Independent variables considered are the Hearing aids technology such as analog and digital with general programmable appliances.

#### **Patients will be divided into following groups**

- Analog hearing aid technology users.
- Digital hearing aid technology users.

Patients were tested through Diagnostic Pure Tone Audiometer, Impedance Audiometer, Oto Acoustic Emission and Speech Audiometry and Hearing Aid(s). The patients were evaluated using the specialized tests like pitch and loudness matching, residual inhibition (RI), Minimum masking Level and Loudness discomfort level to assess the type and severity of tinnitus and Hearing aid trial for selection of hearing aid. Patients were provided suitable hearing aids and proper instructions were given to them to use the hearing aids at least two hours per day for a period of minimum 6 months followed by the post analysis. Tinnitus Handicap Inventory (THI) (Newman *et al*, 1996) questionnaire is considered one of the most standardized, reliable and easy to administer questionnaires in the field of tinnitus. The THI Questionnaire comprises of 25 questions with self-assessment on three point rating scale such as Yes/Sometime/No. A pre and post THI analysis was done on all the participants considered and then detailed statistical analysis was carried out within the population as well as across the two groups. Statistical analysis included paired sample t-test to determine the changes across the two groups. Mann-Whitney U test has been done to know whether the data was distributed normally across the two populations.

## **RESULT**

A detailed statistical analysis was done and the following results got established: *Table 1. Mean, SD, Standard error values of Pre and Post analog and digital hearing aid usage* If we look directly into the pre and post values of both the conditions i.e. usage of analog or digital hearing aids, we can see a significant improvement in the pre and post scores and

also the tinnitus severity level has greatly reduced after usage of hearing aids. This tells us the fact that usage of any amplification device shall benefit the tinnitus problem, be it analog or digital hearing aid. A clear statistical significance is seen when a paired sample correlation was carried out across the data and the results are shown in Table 2.

**Table 1** Mean, SD, Standard error values of Pre and Post analog and digital hearing aid usage

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-analog score	60.7000	20	26.92895	6.02150
	Post-analog score	30.4000	20	23.51797	5.25878
Pair 2	Pre-digital score	78.4000	20	21.11223	4.72084
	Post-digital score	25.7000	20	21.76695	4.86724
Pair 3	Pre-analog severity	3.8500	20	.93330	.20869
	Post-analog severity	2.4500	20	1.19097	.26631
Pair 4	Pre-digital severity	4.6500	20	.81273	.18173
	Post-digital severity	2.2500	20	1.11803	.25000

**Table 2** Paired sample correlation showing significant difference across the pairs

Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	Pre-analog score & post-analog score	20	.935	.000
Pair 2	Pre-digital score & post-digital score	20	-.356	.124
Pair 3	Pre-analog severity & post-analog severity	20	.822	.000
Pair 4	Pre-digital severity & post-digital severity	20	-.362	.117

Table 3 shows us the statistical significance of as we have conducted paired sample-t test suggesting us again that any hearing aid shall give relief from tinnitus when being used by them on a regular basis.

**Table 3** Paired sample-test comparison across pre and post analog and digital hearing aid usage

Paired Samples Test									
		Paired Differences			t	df	Sig. (2-tailed)		
		Mean	Std. Deviation	Std. Error Mean				95% Confidence Interval of the Difference	
								Lower	Upper
Pair 1	Pre-analog score – post-analog score	30.3	9.67417	2.16321	25.77235	34.8277	14.007	19	0
Pair 2	Pre-digital score – post-digital score	52.7	35.30484	7.8944	36.17683	69.2232	6.676	19	0
Pair 3	Pre-analog severity – post-analog severity	1.4	0.68056	0.15218	1.08149	1.71851	9.2	19	0
Pair 4	Pre-digital severity – post-digital severity	2.4	1.60263	0.35836	1.64995	3.15005	6.697	19	0

**Table 4** Normality test table showing us the data not being distributed across the groups

Tests of Normality						
	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre score	.164	40	.009	.889	40	.001
Post score	.187	40	.001	.891	40	.001
Pre severity	.334	40	.000	.755	40	.000
Post severity	.206	40	.000	.845	40	.000

**Table 5** Mann-Whitney U test showing us there is no significant difference across the two groups

Test Statistics				
	Pre-score	Post-score	Pre-severity	Post-severity
Mann-Whitney U	134.500	173.000	101.000	180.500
Wilcoxon W	344.500	383.000	311.000	390.500
Z		-1.777	-.732	-2.961
Asymp. Sig. (2-tailed)	.076	.464	.003	.584
Exact Sig. [2*(1-tailed Sig.)]	.076 <sup>b</sup>	.478 <sup>b</sup>	.007 <sup>b</sup>	.602 <sup>b</sup>

**Table 6** Mean and S.D. of the two groups showing no difference across both the groups. Report

Group		Pre-score	Post-score	Pre-severity	Post-severity
Analog-users	Mean	60.7000	30.4000	3.8500	2.4500
	N	20	20	20	20
	Std. Deviation	26.92895	23.51797	.93330	1.19097
Digital-users	Mean	78.4000	25.7000	4.6500	2.2500
	N	20	20	20	20
	Std. Deviation	21.11223	21.76695	.81273	1.11803
Total	Mean	69.5500	28.0500	4.2500	2.3500
	N	40	40	40	40
	Std. Deviation	25.51013	22.49325	.95407	1.14466

A simultaneous normality test was done to assess whether the data is normally distributed. Kolmogorov-Smirnov with Shapiro-Wilks Test was done and the results showed that the data was not normally distributed across the groups Table 4.

Since our data was not normally distributed, A Mann-Whitney U test was done to determine the changes across the two groups of participants. The results showed that there was no significant difference across the two groups hence this shows us that both the hearing aids have the same impact in tinnitus and both can similarly alleviate tinnitus equally when compared as a whole. Table 5. Shows the results below.

Mean and S.D. was also calculated for the two groups and results showed the similar results respectively as shown above in Table 6.

## DISCUSSION

Our study showed significant relief of tinnitus for both groups who have used hearing aids viz. analog and digital type of aids. Though patients didn't prefer at the beginning maybe because of the compromised aesthetic conditions but eventually due to

its significant relief from tinnitus, the individuals started accepting it. Our study had supported the study done by Kochkin and Tyler (2008) who also found benefits for tinnitus individuals who had used hearing aids respectively and found alleviating symptoms for nearly 60% of the population.

Our study also supported with the studies conducted by Häberle and Kristensen (2012) and Saltzman *et al* in 1947, Melin *et al* 1987 who found tinnitus being a more severe problem and being relieved to some extent by usage of hearing aids respectively.

Hoare *et al*, 2014 conducted a study on amplification characteristics through hearing aids for patients with tinnitus and simultaneous hearing loss and they had found improvement in the tinnitus inhibition after usage of hearing aids but there was no change in the quality of the tinnitus being perceived. Now this study was in support with our study but in our study

the quality has not been assessed by us. Hence in our future indications, our study can be carried forward in terms of quality assessed too.

The functioning of hearing aids have been effective in reducing tinnitus, it is of opinion that due to the noise created inside the instrument that masked the tinnitus and the higher amplification characteristics of the hearing aid that is causing the masking of the tinnitus noise being heard by the patient.

If we talk about cochlear implants, studies have indicated that there has been improvement in tinnitus for CI users but again the cost of CI is way higher compared to an analog or a digital aid. Hence our study suggests all future audiologists to counsel patients to opt for cost effective procedures, thus indicating analog and digital hearing aid respectively.

## CONCLUSION

Thus our study shows that problem of Tinnitus can be alleviated not just only by counseling the client to ignore the tinnitus noise being heard, also getting treatment for conductive pathology thereby reducing the over-amplification of internal noise as well as tinnitus is not a complete solution; the solution is to use amplification also and that could be also added in the treatment approaches. Apart from Tinnitus masker therapy, the individuals can now use hearing aid also for reducing tinnitus. Also clinicians can also plan a proper management program to benefit clients from tinnitus respectively.

Limitations include a lack of comparative study across CI and hearing aid, lack of quality of life assessment respectively and also a larger sample can be also used for the same.

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