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The Effectiveness of Hearing Aid and Combined Devices (Hearing Aid+ Tinnitus Masker) in the Management of Tinnitus

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Abstract
We have conducted this study to determine the effectiveness of hearing aids and combined hearing and masking devices in improving the severity of tinnitus, sleep disturbance, emotional status, concentration, and hearing impairment in patients suffering from tinnitus. It was a quasi-experimental study done in the ENT department at KEMU/Mayo Hospital, Lahore, from March 2021 to May 2021. 147 patients presenting with sensorineural hearing loss and tinnitus on pure tone audiometry of both genders aged between 20 and 80 years were included in the study and those with conductive hearing loss, mixed hearing loss, and patients suffering from psychiatric disorders were excluded from the study. Tinnitus impact on concentration, sleep, emotion, and hearing was assessed with lowa tinnitus activity questionnaire and tinnitus severity was assessed with the Tinnitus severity index (TSI) before use of a hearing aid or combined device. Hearing Aid (HA)/ Combined device (Hearing Aid +Tinnitus Masker) was dispensed to all patients and patients were re-assessed by lowa tinnitus questionnaire and TSI after 12 weeks. $P<0.05$ was taken as statistically significant. Out of 147 patients, 73 (49.7%) were females and 74 (50.3%) were males. The mean age of patients was 53.91±9.19. The mean concentration score before treatment was 151.87±28.06 and after treatment was 99.67±34.81 ($p<0.05$). The mean sleep score before and after the hearing aid/tinnitus masker was 133.14±33.14 and 84.51±34.82($p<0.05$). The mean Emotion score was 133.21±23.48 and 87.32±34.55 ($p<0.05$). The mean Hearing Score was 88.06±23.59 and 45.19±23.95($p<0.05$). Mean TSI was 30.04±6.30 and 17.56±7.39. Hearing aids and combined devices are effective tools in improving sleep disturbance, emotional status, concentration, hearing, and decreasing the severity of tinnitus, and can improve quality of life significantly.
Key Words: Tinnitus, Tinnitus Masker, Hearing Aids, Tinnitus Severity Index, lowa Tinnitus Activities Score, Combined devices.

INTRODUCTION

Tinnitus is a strange and complex human auditory system disorder. The word "Tinnitus" is derived from the Latin word "tinnier" which means "ring".[1] Tinnitus is a phantom sensation of sound in the absence of any external stimuli.[2] Exact pathophysiological mechanisms involved in the origin of tinnitus are yet not well defined and several risk factors such as hearing loss, psychological disorders, and neurological and systemic diseases are associated with the etiology of tinnitus.[3] Sensorineural hearing loss is considered the most important predisposing factor for the origin of tinnitus and up to 80% of patients suffering from hearing loss are reported to have tinnitus.[4] In some people, tinnitus goes far from the phantom sensation of sound i.e. troublesome tinnitus, causing problems like insomnia, difficulty concentrating, and poor psychological wellbeing, ultimately decreasing symptom-specific health-related quality of life.[5] Tinnitus is a common condition and the prevalence of tinnitus in different regions of the globe is reported to range from 5 to 30 %.[6] Troublesome tinnitus is reported in up to 15% of the adult population and the prevalence of troublesome tinnitus increases with age.[7] Chronic tinnitus i.e. Tinnitus for more than three months can impair quality of life significantly resulting in impaired cognition, attention, reduced concentration, and disturbed sleep. Bothersome and chronic tinnitus is also associated with anxiety, depression, Isolation, mood disorders, and poor performance at the workplace which may lead to significant social and psychological dilemmas.[8]
Different management strategies such as Tinnitus Retraining Therapy, tinnitus maskers, hearing aids, and counseling have been developed and a multidisciplinary approach is recommended to manage this condition.[9] Tinnitus can be managed either by interrupting the sound signal by presenting a sound stimulus or by therapies that are directed at decreasing accompanying anxiety, distress, and depression.[10] Sound therapy using amplification devices, sound generators, or combined devices can significantly reduce tinnitus symptoms and improve quality of life.[11]Hearing aids can modulate the volume of external sound to the point that it will mask (cover) the tinnitus sound. It helps the brain to focus on the external sounds rather than on the sounds of tinnitus.[12] Narrow-band noise is often used in the tinnitus-masking therapy that is achieved using hearing devices or combined devices (masker and hearing device).[13] An increase of auditory stimulus as a result of sound amplification with

hearing aids can induce secondary plasticity that in turn help the sufferer to decrease the nuisance associated with tinnitus as has been suggested by studies of plasticity.[14] A lot of research work has been conducted in different parts of the globe on the effectiveness of sound therapy in the management of tinnitus by using hearing aids and tinnitus maskers; however, locally there is a lack of evidence-based research work. Keeping in mind the paucity of local data, the present study was conducted to determine the effectiveness of hearing aids or combined devices in improving patients' emotional, psychological, hearing, and sleep disturbances and to see the reduction in tinnitus symptoms severity.

MATERIAL AND METHODS:

This quasi-experimental study was conducted at the ENT department at Mayo Hospital, Lahore from March 2021 to May 2021, after obtaining the ethical approval from the university ethical committee (International Review Board King Edward Medical University, Lahore). A consecutive purposive sampling technique was used. A sample size of 147 patients was estimated by using a 5% level of significance, 90% power of test with expected mean value before the use of hearing aids or combined devices mean scoring as 41% and after the use of hearing aids mean scoring as 25 % by using the formula

$$n = \frac{\left\{Z_{1-\alpha}\sqrt{2\bar{P}(1-\bar{P})} + Z_{1-\beta}\sqrt{P_1(1-P_1)+P_2(1-P_2)}\right\}^2}{(P_1-P_2)^2}$$

Whereas,

$Z_{1-\alpha}$ = Confidence level 95% = 96%

P_1 = Population proportion 1 = 41%

P_2 = Population proportion 2 = 25%

$Z_{1-\beta}$ = Power of test = 90%

Patients who presented with hearing loss and tinnitus undergo pure tone audiometry and Immittance audiometry. Patients who were diagnosed to be suffering from sensorineural hearing loss and tinnitus were included in the study. Patients with conductive and mixed hearing loss, known psychiatric disorders, and those patients who refused to use a hearing aid/tinnitus masker were excluded from the study. Demographic information was noted, history and otolaryngological examinations were done and cardiovascular co-morbidities were recorded. Patients were subjected to audiological investigations including pure tone audiometry, Immittance audiometry, and tinnitus matching to assess hearing loss and tinnitus. All patients were subjected to lowa Tinnitus Activities Questionnaire, and Tinnitus Severity Index (TSI). Lowa Tinnitus Activities Questionnaire is a twelve-item questionnaire that is designed to see the effects of tinnitus on concentration, emotion, hearing, and sleep. Likert-like scale questionnaires were applied to the participants by the researcher themselves to alley any difficulties in understanding the questions. Patients answered 0 (zero) for strongly disagree and 100 for strongly agree with the question statement. The tinnitus severity index was used to assess the severity of tinnitus. A hearing aid alone or combined device including hearing aid and tinnitus masker was dispensed to the patient and after twelve weeks, patients were assessed by Lowa Tinnitus Activities Questionnaire and TSI. Statistical analysis was done by SPSS version 22. For quantitative variables like age, mean and standard deviations were calculated; while for qualitative variables like gender, frequencies and percentages were calculated. Paired sample t-test was used to compare the mean scores of patients before and after using hearing devices. A p-value of <0.05 was considered statistically significant.

RESULTS

Out of 147 patients, 73 (49.7%) were females and 74 (50.3%) were males. The mean age of patients was 53.91±9.19. Relative frequencies of patients suffering from mild to moderate, moderate to severe, and severe to profound hearing loss are presented in Table 1. 46 (31.3%) patients were suffering from unilateral and 101 (68.7%) from bilateral hearing loss. 37 patients (25.2%) were suffering from unilateral tinnitus, 91 (61.9%) from bilateral and 19 (12.9%) from central tinnitus. 3 (2.0%) patients were suffering from very mild, 20 (13.6%) mild, 89 (60.5%) moderate, 25 (17.0%) severe and 10 (6.8%) catastrophic tinnitus. High pitched tinnitus was present in 102 (69.4%), low pitched in 28 (19.0%) and mixed in 17 (11.6 %) patients.

Table 1: Hearing Loss and Tinnitus Characteristics

	Frequency (n =147)	Percentage
Severity of hearing loss		
Mild to Moderate	50	34.0 %
Moderate to Severe	69	46.9%
Severe to Profound	28	19.0 %
Hearing loss laterality		
Unilateral Hearing Loss	46	31.3%
Bilateral Hearing Loss	101	68.7%
Tinnitus localization		
Unilateral Tinnitus	37	25.2%
Bilateral Tinnitus	91	61.9%
Central Tinnitus	19	12. 9%
Tinnitus Severity		
Very Mild	3	2.0%
Mild	20	13.6%
Moderate	89	60.5%
Severe	25	17.0%

Catastrophic	10	6.8%
Tinnitus Frequency		
High Pitched	102	69.4%
Low Pitched	28	19.0%
Mixed	17	11.6%

The mean concentration score before treatment was 151.87±28.06 and after treatment was 99.67±34.81 ($p<0.05$). The mean sleep score before and after the hearing aid/tinnitus masker was 133.14±33.14 and 84.51±34.82($p<0.05$). The mean Emotion score was 133.21±23.48 and 87.32±34.55 ($p<0.05$). The mean Hearing Score was 88.06±23.59 and 45.19±23.95($p<0.05$). Mean TSI was 30.04±6.30 and 17.56±7.39.

DISCUSSION

This study included 147 patients diagnosed with sensorineural hearing loss and tinnitus on basis of history and diagnosis was confirmed by pure tone audiometry and Immittance audiometry. The mean age of patients in this study was 53.91±9.19 which is comparable to the study of Stohler NA, et al.et al conducted in the United Kingdom.[14] In this study incidence of tinnitus in males and females was equal for males and females and this finding is also comparable to the study of Stohler NA, et al.[15] while it contrasts with Zhang W study which reported that women have less prevalence of tinnitus than men; however, the advantage disappears with age.[16] Tinnitus has been reported in approximately 15% of the global population and the prevalence of chronic tinnitus increases with age. Increased prevalence of chronic tinnitus with advancing age can be explained on the basis that hearing loss associated with advancing age is an important risk factor for the development of tinnitus.[17] In this study, 17% of patients were suffering from severe tinnitus and this study finding is comparable to a study by McCormack A et al. in 2016 which concluded that the prevalence of severe tinnitus ranged from 3.0% to 30.9%.[18] Different risk factors are associated with the development and severity of tinnitus such as increased age, hearing loss, cardiovascular co-morbidities, and smoking. In this study advanced age of patients, severe sensorineural hearing loss, and the presence of cardiovascular co-morbidities in the majority of patients may explain the development of severe tinnitus.[19,20,21]

Tinnitus is a highly heterogeneous entity and multiple management strategies with variable treatment outcomes are available for chronic tinnitus including counseling, pharmacological treatment, hearing aids, sound therapy, Tinnitus Retraining Therapy (TRT) Cognitive Behavioral Therapy and definitive treatment for tinnitus has yet to be developed.[22]Hearing Aids either alone or combined hearing aid and tinnitus masker are recommended for the management of tinnitus in patients with hearing loss. Tinnitus perception can be reduced by the use of these devices and quality of life can be improved by reducing stress associated with tinnitus. [23,24] Postulated mechanisms to reduce nuisance associated with tinnitus by hearing aid and tinnitus maskers include triggering neuroplasticity in the brain, helping in habituation, and distracting from tinnitus.[25]. Mean TAQ scores improved significantly in this study after the use of a hearing aid alone or in combination with a tinnitus masker. The study findings are comparable to a study by Cabral J et al. conducted in 2016 which states that there is a significant improvement in tinnitus perception and improved quality of life after the use of hearing aids alone or in combination with tinnitus masker.[26]Severity of tinnitus in Hearing impaired patients with tinnitus can be reduced by fitting hearing aid only. In this study, 67.3% of patients preferred only a hearing aid for tinnitus suppression, and the remaining patients used combined devices this finding is comparable to the study of Lee, H.J.et all conducted in 2022 which concluded that hearing-impaired patients with tinnitus are satisfied with their hearing aids in reducing tinnitus perception and improving quality of life.[27-39] The duration of this study is short- and long-term effects of hearing aids and combined devices on the perception of tinnitus were not sought, so future trials with long-term follow-up of patients are required to see the effectiveness of these devices after prolonged use. This study was a small-scale study as it was self-funded and it was designed to obtain initial data so that in future more comprehensive trials may be conducted. In this study, hyperacusis was not taken into consideration which is often reported by tinnitus patients. Future studies should ensure to address hyperacusis.

CONCLUSION

We concluded that patients suffering from sensorineural hearing loss and tinnitus can be benefitted from the use of hearing aids or combination devices comprising a hearing aid and a tinnitus masker. Role of Hearing Aids and combined devices in the treatment of tinnitus include increasing background noise, a distraction from tinnitus, and triggering of plastic changes in the auditory system, along with aiding in better communication thus decreasing the stress of tinnitus.

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