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Original Research Article

Outcome of audiometric masking therapy on subjective tinnitus patients in different age groups

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ABSTRACT

Background: Theoretical consideration suggests an impact of the age at tinnitus onset influencing tinnitus distress. The use of masking for tinnitus is a primary method of treatment of tinnitus. The objective was to study effectiveness of masking by introducing audiometric reference signal in treatment of subjective tinnitus.
Methods: The 90 patients (45 males and 45 females) were assessed by pure tone audiometer. Patients were divided into 6 age group sets for evaluation. The reference signal (90 to 100 dB SPL for 2-3 minutes in tinnitus ear of frequency 1000 Hz) was used for masking therapy. Outcome of the study was measured by using the tinnitus handicap inventory (THI) score and awareness time (tinnitus perception) before and after audiometric reference signal masking therapy. Success rate was measured to measure therapeutic efficacy.
Results: Our results depict improvement in subjective tinnitus by 57.78% (in males), 55.56% (in females) and overall 56.67% success in patients aged between 21 to 60 years by using our audiometric reference signal masking therapy. Regarding gender, the finding of THI score, Awareness time and Success rate in our study showed females being affected more than males. Our study also evidenced a highest percentage of tinnitus after the age of 70 followed by the decades 61–70 and 51–60.
Conclusions: Our new economically viable approach to subjective tinnitus patients by audiometric reference signal seems to be an effective in improving the patient's distress in age group 21 to 60 years. Before taking decision for selection of high cost hearing aids, we can use it for poor people.

Keywords: Subjective tinnitus, Audiometer, Masking therapy

INTRODUCTION

Tinnitus is defined as an unwanted auditory perception of internal origin, usually localized, and rarely heard by others.[1] Subjective tinnitus, which is more common, is heard only by the patient.[2] The mechanism that produces tinnitus remains poorly understood.[3] Tinnitus may originate at any location along the auditory pathway from the cochlear nucleus to the auditory cortex. Some leading theories include injured cochlear hair cells that discharge repetitively and stimulate auditory nerve fibers in a continuous cycle, spontaneous activity in individual auditory nerve fibers, hyperactivity of the auditory nuclei in the brain stem, or a reduction in the usual suppressive activity of the central auditory cortex on peripheral auditory nerve activity.[4] Three different types of devices are used to offer relief for tinnitus patients: 1) tinnitus maskers, 2) tinnitus instruments, and 3) hearing aids.[5] It appears that reasonable success can be achieved with these masking devices if care is taken in fitting them.

Although the results obtained with the masking devices are not as positive as we had hoped in our clinic benefitted from some type of masking instrumentation. These masking devices also cost more which is not affordable for poor people. The final measurement in the clinical evaluation of the tinnitus patient is to determine if the tinnitus can be inhibited by exposure to the masking sound.[6] Upon removal of the masking noise, patients who exhibit tinnitus inhibition will report complete elimination or reduction of the tinnitus. This intriguing phenomenon has been coined "residual inhibition" and is generally measured by presenting the masking signal to the patient for one minute and then, following removal of the noise, observing the duration of tinnitus inhibition.[7] Thus this article discusses the new reference signal by audiometer (90 to 100 dB SPL for 2-3 minutes in tinnitus ear of frequency 1000 Hz) used for evaluating tinnitus.

METHODS

Study design with ethical permission

The present study was carried out in the Department of Otorhinolaryngology, Al Ameen Medical College and Hospital (Vijayapur, Karnataka, India), from January 2016 to December 2016. The study protocol was approved by Institutional Ethical Committee and consent was obtained from all the subjects before the study being started. Patients with co-existing psychiatric problems were excluded from the study. All the subjects were matched according to socio-economical status. Ninety subjective tinnitus patients of both the sexes were considered for the study.

Collection of data

After collection of personal data all patients underwent to a careful detailed medical history to identify tinnitus-related pathologies and other health diseases, which included ear, nose, and throat specialist history, and otological examination. Patients were divided into six age group sets for evaluation as shown in Figure 1. All patients were evaluated using the same systematic protocol for evaluation of tinnitus and sound intolerance. This protocol was the basis for selecting the clinical data, features of tinnitus, and symptoms for review.

Audiometric masking therapy

The patients were assessed by pure tone audiometer (Model No. ALPs AD2100) with the help of our reference signal (90 to 100 dB SPL for 2-3 minutes in tinnitus ear of frequency 1000 Hz) for masking therapy. At the initial treatment appointment, treatment specific counseling was administered. When amplification was used, real ear testing was performed routinely. Continuing treatment appointments were scheduled at 3rd day (first follow-up), 6th day (second follow-up) and 12th day (third follow-up) after the first treatment appointment. One day prior to each treatment visit, patients were provided regional language translated (Kannada version) THI questionnaire.[8] At each appointment, the study audiologist: 1) checked the written questionnaires for completeness; 2) administered our new approach to tinnitus patients by audiometric reference signal 90 to 100 (dB SPL) for 2-3 minutes in tinnitus ears of frequency 1000 Hz; and 3) performed audiologic and tinnitus testing. The treatment specialist then met with the patient to check the performance.

Outcome measures

For data analysis the age and gender were considered. Patients were evaluated by using the Tinnitus Handicap Inventory (THI) before and after audiometric masking therapy. The THI score was graded as negligible (0-16), mild (18-36), moderate (38-56), severe (58-76), or catastrophic (78-100).[8] Awareness time of patients who were followed the treatment was noted down. Numerical description of hours of tinnitus perception (awareness hours) was measured from 0 to 24 scale with 24 most severe.[9] To evaluate percent improvement test, the mean values of the THI Score and awareness time during each follow up were subtracted from the respective initial (before treatment) mean values of the THI Score and awareness time the differences were calculated in terms of percent improvement. To measure therapeutic efficacy success rate was measured. The successful treatment rate was defined as the proportion of patients who improved in THI (<20 score).

Data were collected and analyzed by using SPSS 20 software. The outcome of THI score and awareness time were expressed in terms of mean±standard deviation. One-way analysis of variance (ANOVA) test was carried out to test for any differences between the mean values of the THI score and awareness time. The mean values of the THI score and awareness time were compared with their respective before treatment values by the post-hoc t-test. A value of $p<0.05$ was interpreted as statistically significant. The statistically significant values were expressed with different superscripts such as a, b, c etc.

RESULTS

A total of 90 subjective tinnitus patients, 45 males and 45 females were evaluated. The patients were aged from 22 to 76; the majority of the cases were aged between 41 and 70 (Figure 1).

Table 1 and Figure 2, in male subjective tinnitus patients showed highly statistical significant improvement in mean THI score after treatment as compared with their before treatment score: age group 21-30 (12.00 vs. 30.00) which is 60% improvement, Age group 31-40 (20.23 vs. 44.83) which is 54.87% improvement, Age group 41-50 (35.43 vs. 55.11) which is 35.11% improvement and age group 51-60 (42.13 vs. 60.50) which is 30.36% improvement. Age group 61-70 (60.23 vs. 65.25) which is 7.69% improvement and age group 71-80 (70.67 vs.

75.71) which is 6.67% improvement showed least statistical significance in mean THI score as compared with their before treatment score.

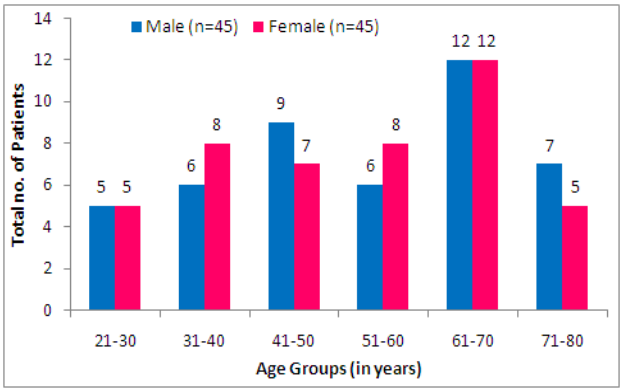

Figure 1: Gender distribution of subjective tinnitus patients (n =90) in different age groups.

Table 2 and Figure 2, in female subjective tinnitus patients showed highly statistical significant improvement in mean THI score after treatment as compared with their before treatment score: age group 21-30 (15.00 vs. 36.22) which is 58.59% improvement, age group 31-40 (18.34 vs. 39.54) which is 53.62% improvement, age group 41-50 (35.65 vs. 50.54) which is 29.32% improvement and age group 51-60 (47.98 vs. 67.91) which is 29.42% improvement. Age group 61-70 (65.66 vs. 72.34) which is 7.23% improvement and Age group 71-80 (75.43 vs. 80.76) which is 6.60% improvement showed least statistical significance in mean THI score as compared with their before treatment score.

Table 3 and Figure 3, in male subjective tinnitus patients showed highly statistical significant improvement in mean awareness time after treatment as compared with their before treatment awareness time: age group 21-30 (4.22 vs. 19.23) which is 78.06% improvement, age group 31-40 (5.59 vs. 20.56) which is 72.81% improvement, age group 41-50 (5.65 vs. 21.67) which is 73.93% improvement and age group 51-60 (10.98 vs. 21.88) which is 49.82% improvement. Age group 61-70 (20.00 vs. 22.44) which is 10.87% improvement and age group 71-80 (21.08 vs. 22.98) which is 8.27% improvement showed least statistical significance in mean awareness time as compared with their before treatment awareness time.

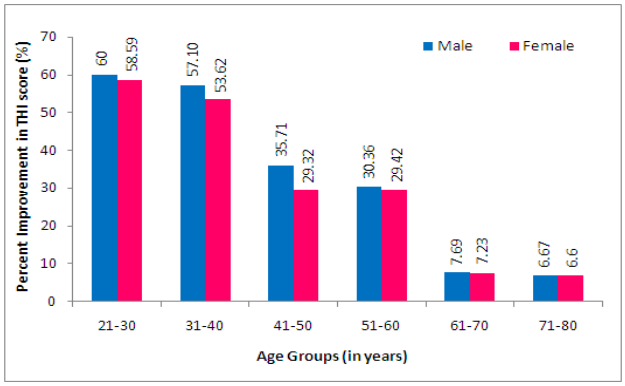

Figure 2: Percent improvement in tinnitus handicap inventory (THI) score of subjective tinnitus patients (n =90) in different age groups.

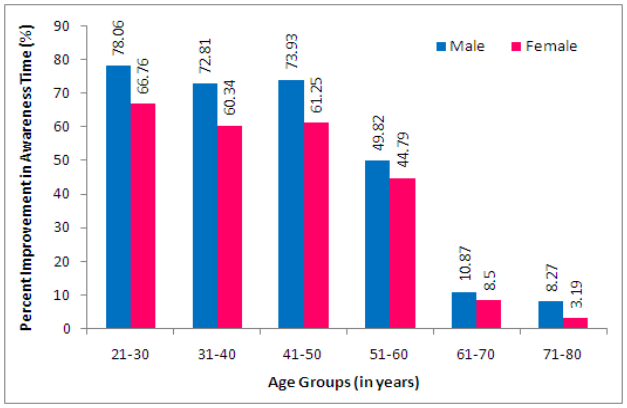

Figure 3: Percent improvement in awareness time of subjective tinnitus patients (n =90) in different age groups.

Table 1: THI Score of male subjective tinnitus patients (n =45) in different age groups before and during audiometric masking therapy.

Age groups (years)	Total no. of patients	THI score before treatment	THI score during audiometric masking therapy		
			1st follow up	2nd follow up	3rd follow up
21-30	05	30.00±1.32[a]	24.15±4.11[b]	20.33±8.22[c]	12.00±2.32[d]
31-40	06	44.83±3.55[a]	37.00±2.58[b]	31.33±5.45[c]	19.23±5.77[d]
41-50	09	55.11±4.15[a]	50.26±5.82[b]	42.00±12.00[c]	35.43±15.24[d]
51-60	06	60.50±2.15[a]	55.78±1.77[b]	50.00±3.99[c]	42.13±2.33[d]
61-70	12	65.25±1.82[a]	60.45±4.89[b]	60.89±4.99[b]	60.23±3.56[b]
71-80	07	75.71±2.91[a]	70.76±2.67[b]	70.56±2.98[b]	70.67±2.67[b]

THI: Tinnitus Handicap Inventory. All the values quoted as the Mean ± standard deviation. In each row, values with different superscripts (a, b, c, d) indicate statistically significant difference from each other ($p<0.05$). Post-hoc t-test analysis was used to test for differences among the means when analysis of variance (ANOVA) indicated a significant p value ($p<0.05$).

Table 2: THI score of female subjective tinnitus patients (n =45) in different age groups before and during audiometric masking therapy.

Age groups (years)	Total no. of patients	THI score before treatment	THI score during audiometric masking therapy		
			1st follow up	2nd follow up	3rd follow up
21-30	05	36.22±4.67[a]	29.00±3.77[b]	22.21±3.33[c]	15.00±3.12[d]
31-40	08	39.54±3.11[a]	32.32±6.00[b]	26.45±8.12[c]	18.34±5.55[d]
41-50	07	50.44±4.88[a]	45.11±4.65[b]	39.76±6.34[c]	35.65±6.34[d]
51-60	08	67.98±6.23[a]	60.34±8.33[b]	52.98±7.45[c]	47.98±4.92[d]
61-70	12	72.34±.9.65[a]	65.76±7.45[b]	65.32±7.98[b]	65.66±6.00[b]
71-80	05	80.76±10.44[a]	75.54±6.35[b]	75.21±4.45[b]	75.43±6.88[b]

THI: Tinnitus Handicap Inventory. All the values quoted as the Mean ± standard deviation. In each row, values with different superscripts (a, b, c, d) indicate statistically significant difference from each other ($p<0.05$). Post-hoc t-test analysis was used to test for differences among the means when analysis of variance (ANOVA) indicated a significant p value ($p<0.05$).

Table 3: Awareness time of male subjective tinnitus patients (n =45) in different age groups before and during audiometric masking therapy.

Age groups (years)	Total no. of patients	Before treatment awareness time	Awareness time (hours)		
			1st follow up	2nd follow up	3rd follow up
21-30	05	19.23±1.67[a]	15.45±1.77[b]	10.08±1.47[c]	4.22±0.91[d]
31-40	06	20.56±2.65[a]	16.11±3.00[b]	12.72±2.12[c]	5.59±1.22[d]
41-50	09	21.67±1.56[a]	15.51±2.33[b]	10.43±1.09[c]	5.65±1.29[d]
51-60	06	21.88±1.45[a]	18.46±0.76[b]	13.09±1.22[c]	10.98±2.03[d]
61-70	12	22.44±.0.77[a]	20.67±2.56[a]	20.12±1.54[a]	20.00±1.43[a]
71-80	07	22.98±1.35[a]	21.34±0.44[a]	21.12±3.57[a]	21.08±2.79[a]

All the values quoted as the Mean ± standard deviation. In each row, values with different superscripts (a, b, c, d) indicate statistically significant difference from each other ($p<0.05$). Post-hoc t-test analysis was used to test for differences among the means when analysis of variance (ANOVA) indicated a significant p value ($p<0.05$).

Table 4: Awareness time of female subjective tinnitus patients (n =45) in different age groups before and during audiometric masking therapy.

Age groups (years)	Total no. of patients	Before treatment awareness time	Awareness time (hours)		
			1st follow up	2nd follow up	3rd follow up
21-30	05	18.65±2.34[a]	16.17±1.61[b]	11.11±1.34[c]	6.20±1.82[d]
31-40	08	19.87±1.23[a]	16.82±2.18[b]	14.50±1.26[c]	7.88±2.34[d]
41-50	07	20.75±0.28[a]	17.37±1.87[b]	14.13±1.45[c]	8.04±2.31[d]
51-60	08	21.41±2.87[a]	19.52±1.21[b]	14.54±2.04[c]	11.82±1.14[d]
61-70	12	23.19±.1.67[a]	21.95±2.56[a]	21.65±1.74[a]	21.22±1.43[a]
71-80	05	23.50±1.21[a]	22.48±0.86[a]	22.32±1.93[a]	22.75±1.46[a]

All the values quoted as the Mean ± standard deviation. In each row, values with different superscripts (a, b, c, d) indicate statistically significant difference from each other ($p<0.05$). Post-hoc t-test analysis was used to test for differences among the means when analysis of variance (ANOVA) indicated a significant p value ($p<0.05$).

Table 5: Successful rate of audiometric masking therapy in different age groups of subjective tinnitus patients (n =90).

Age groups (years)	Total no. of tinnitus patients	Outcome of audiometric masking therapy		Successful rate (%)
		Tinnitus disappeared in male patients (%)	Tinnitus disappeared in female patients (%)	
21-30	10	05/05 (100)	05/05 (100)	100
31-40	14	06/06 (100)	08/08 (100)	100
41-50	16	09/09 (100)	06/07 (85.71)	93.75
51-60	14	06/06 (100)	06/08 (75)	85.71
61-70	24	00/12 (0)	00/12 (0)	0
71-80	12	00/07 (0)	00/05 (0)	0
Total	90	26/45 (57.78)	25/45 (55.56)	56.67

Table 4 and Figure 3, in female subjective tinnitus patients showed highly statistical significant improvement in mean awareness time after treatment as compared with their before treatment awareness time: age group 21-30 (6.20 vs. 18.65) which is 66.76% improvement, age group 31-40 (7.88 vs. 19.87) which is 60.34% improvement, age group 41-50 (8.04 vs. 20.75) which is 61.25% improvement and age group 51-60 (11.82 vs. 21.41) which is 44.79% improvement. Age group 61-70 (21.22 vs. 23.19) which is 8.50% improvement and age group 71-80 (22.75 vs. 23.50) which is 3.19% improvement showed least statistical significance in mean awareness time as compared with their before treatment awareness time.

Table 5 depicts the successful rate of masking therapy treatment in proportion to THI score less than 20. Among subjective tinnitus patients of both the gender and aged from 21 to 40 (n =24 patients) were showed 100% successful rate of masking therapy treatment. The successful rate in 9 male patients of Age Group 41-50 were showed 100% successful rate of masking therapy treatment, whereas in 7 female patients it was 85.71% and overall success rate for this age group was 93.75%. The same trend of decreased rate in female (75% in 8 patients) over male (100% in 6 patients) was observed in age group 51-60 and overall success rate was 85.71% in 14 subjective tinnitus patients. Further in both the gender and aged from 61 to 80 (36 patients) were showed any success of masking therapy treatment. Our study showed overall 56.67% successful rate of masking therapy treatment on 90 subjective tinnitus patients. In terms of gender distribution, success rate was 55.56% in female patients (n =45) and 57.78% in male patients (n =45). This result depicts that male patients were slightly more successful to masking therapy treatment as compared with female patients.

DISCUSSION

Our study clearly showed improvement of subjective tinnitus by using our audiometric reference signal masking 90 to 100 dB SPL therapy for 2-3 minutes in tinnitus ear of frequency 1000 Hz by 57.78% (in males), 55.56% (in females) and overall 56.67% successful rate in patients aged between 21 to 60 years. Regarding gender, the finding of THI score (Table 1, 2 and Figure 1), awareness time (Table 3, 4 and Figure 2) and successful rate (Table 5) in our study showed female being affected more than male in almost all the age groups may be because of their greater longevity. The study performed by Shrestha et al, Cooper and Pinto et al which showed similar results that females were affected more than males.[10-12] The epidemiological data have generally supported a strong association of tinnitus with increasing age; in particular the decade of age in which tinnitus affects more frequently is between 61 and 70 followed by lower decades (41–50).[13,14] A total of 90 subjective tinnitus patients, 19 out of 45 males and 17 out of 45 females were aged from 61 to 80 years. These in total 36 out of 90 patients showed no satisfactory results in THI score (<8% improvement), awareness time (<11%) and successful rate was 0%. Our study evidenced a highest percentage of tinnitus after the age of 70 followed by the decades 61–70 and 51–60; it is probably due both to the degree of hearing impairment and to the high incidence of predisposing conditions (i.e. cardiovascular and metabolic diseases). The main finding of our analysis is an influence of the age at tinnitus onset on subjective tinnitus. Higher age at tinnitus onset is associated with higher tinnitus related distress.[15] In this context higher subjective tinnitus at higher age of onset suggests an age-related decline in the efficiency of this compensatory mechanism for tinnitus. Thus our finding is in line with the observation that a decrease of cognition is related to higher tinnitus related distress.[16] Future studies are invited to further characterize the interactions between age related changes in neuroplastic potential, cognitive function and their influence on subjective tinnitus. Therefore we recommended hearing ads to 36 unsuccessful patients out of 90 aged between 61 to 80 years. From the beginning of audiometric reference signal masking (90 to 100 dB SPL) therapy for 2-3 minutes is the effective therapy to improve all three of outcome measures (THI, awareness hours, successful rate) till the 3rd follow-up in patients aged between 21 to 60 years. These results definitely showed the effectiveness of our audiometric reference signal masking (90 to 100 dB SPL) therapy to 54 out of 90 patients aged between 21 to 60 years.

CONCLUSION

The finding of our study showed female being affected more than male in almost all the age groups. Here we suggest that the age at subjective tinnitus might be an additional factor. Our new approach to tinnitus patients by audiometric reference signal masking 90 to 100 dB SPL therapy for 2-3 minutes in tinnitus ear of frequency 1000 Hz seems to be effective in improving the patient's distress in age group 21 to 60 years due to tinnitus. This therapy is economically viable or cheaper so before taking decision for selection of high cost hearing aids, we can use tinnitus masking therapy for poor people. Further study with more subjects is necessary to draw a more precise conclusion.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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