Hearing aid for tinnitus management: A comparison study of amplification strategies on audibility of tinnitus

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Abstract

Objective: *The present study aimed at finding the best amplification strategy that provides tinnitus relief in a quiet environment in patients with Sensorineural hearing loss who have bothersome tinnitus. The following objectives were formulated a) To measure Minimal Masking Level (MML) on tinnitus suppression b) to find the relation between tinnitus pitch and gain at tinnitus pitch in each strategy (DSL i/o v -5 at compression threshold of 30 dBSPL, DSL i/o v-5 at compression threshold of 50 dBSPL, NAL-NL1 at compression threshold of 30 dBSPL and NAL-NL1 at compression threshold of 50 dBSPL) and b) to determine the best amplification strategy that gives relief from tinnitus using paired comparison method.*

Method: *A one shot posttest only and randomized repeated measures research design was utilized. Fourteen participants with unilateral and bilateral tone like tinnitus participated in the study whose age ranged from 20 to 80 years. These participants were made three grouped based on the scores of Tinnitus Handicap Inventory (THI). From each participant, MML on tinnitus suppression and the best program selected among four strategies provided tinnitus relief were measured.*

Results*: In each group of participants, MML on tinnitus suppression was descriptively analyzed. A spearman's correlation revealed no significant relation between MML at tinnitus pitch and gain at tinnitus pitch. Each group of participants showed no preference among four strategies in hearing aid.*

Conclusion: *Other than prescriptive formula and compression threshold, a few features in hearing aid (open fit, omnidirectional, deactivated DNR and optimizing gain at tinnitus pitch) have an effect in providing relief from tinnitus. However, a caution must be taken in fitting hearing aid to tackle both hearing loss and tinnitus by effectively using the options available in aid. This is because in amplifying the ambient noise from hearing aid there would be a high chance of rejecting it because of annoyance experience from amplifying ambient noise. Thus, to avoid annoyance during conversation, a separate program can be set in hearing aid to obtain relief from tinnitus especially in quiet environment*

Key words: *Tinnitus, hearing aid, amplification strategies*

Introduction

Common term of tinnitus is known as 'Ringing in the ears' is a perception of sound without any external stimulus (Norena and Eggermont, 2003). Most patients describes tinnitus quality as ringing (38%), buzzing (11%), Crickets(9%) and humming (5%) as reported by Henry, Dennis and Schehter(2005). Tinnitus is majorly associated with either unilateral or bilateral hearing loss (Kim et al, 2015). Assessment of tinnitus pitch and loudness is a preliminary measures in which tinnitus patient necessitates in initiating with any rehabilitation program. Minimum Making Level (MML) is one such assessment method uses masking method (Feldmann, 1971) to assess tinnitus pitch and loudness. In MML an intensity of narrowband noise required to mask tinnitus was found across frequencies. Wegal and Lane (1924) observed lowest masking level required at a frequency close to tinnitus pitch.

Tinnitus is more common in individuals with hearing loss. In one year of period prevalence study on tinnitus by Thirunavukkarasu and Geetha (2015) reported in 97.5 % of individuals having tinnitus had hearing loss. In addition, older adults with an age 60 years and above experienced tinnitus than compared to other age groups. Further, 23.7% of individuals with tinnitus had moderate to moderately severe degree of hearing loss.

Hearing aids are one of the management options used since 1940s till date, as it suppresses tinnitus. Hearing aid causes relief from tinnitus by many ways including: 1) masking the tinnitus from ambient noise of the device 2) Reduces the audibility of tinnitus by paying less attention and 3) improves quality of life and or secondary effect of tinnitus by reducing anxiety, stress , and depression (Kochkin& Tyler , 2008). Surr, Montgomery and Mueller (1985) reported that approximately 50% of tinnitus patients achieved some relief from hearing aid. In yet another study by Surr , Kolb , Cord and Garrus (1999) found an average of 10% improvement in tinnitus handicap over 6 weeks following the fitting of hearing aid users. In contrast, Melin, Scott, Lindberg and Lyttkens(1987) said that hearing aid alone will not decrease the tinnitus and associated problem if any. They reported that likelihood of reduction in tinnitus depends on careful selection of hearing aid characteristics, with the intention of reducing

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tinnitus audibility. Some of the options in hearing aid can be changed for tinnitus management which includes; using open fit rather than fitting a hearing aid with ear mould (Parazzini, Del Bo, Jastreboff,, Tagnola and Ravazzani , 2011) ,low compression thresholds(Wise, 2003) switching off the noise reduction circuit (Ricketts and Mueller, 1999), sensitivity of microphone turned on to pick up the signal in all direction (Ricketts and Mueller , 1999) and finally prescribing the gain using DSL i/o for ameliorating the effect of hearing loss on perception of speech (Searchfield, 2010).

In open fit of hearing aid, environmental sound can easily take entry into the ear canal there by tinnitus sound is partly reduced (Sheldrake, Coles & Foster , 1995). However, blocking the ear canal with molds can produce occlusion effect there by internal physiological noise enhances and at the same time tinnitus sound also increases. Thus, hearing aid fitted with dome is more effective in suppressing tinnitus than compared to ear mould. Wise (2003) conducted study by changing the compression threshold in hearing aid on audibility of tinnitus. It was hypothesized that compressor in hearing aid activated by input signal produce the ambient noise which in turn suppresses tinnitus. The results revealed that low compression kneepoint is effective in reducing the audibility of tinnitus as it produces circuitry noise while amplifying low input signal to audible level. Thus, in wide dynamic range compression with low compression kneepoints of around 20-45 dB SPL was recommended for suppressing tinnitus

Other options in hearing aids such as changing the sensitivity of microphone and activation of noise reduction circuit were used to understand speech against background noise. However, these options were disabled in hearing aid in individuals having hearing loss with bothersome tinnitus. Ricketts and Mueller (1999) conducted study by deactivating the noise reduction algorithm and changing sensitivity of microphone on tinnitus suppression. It was found that in those participants who wore hearing aid with settings switching off of DNR and omnidirectional microphone benefitted maximally on tinnitus relief. This is because microphone captures signals from all direction. In addition, hearing aid allocates gain towards hearing loss in each band does not reduces irrespective of temporal change by noise and speech. The resultant amplified sound comprised of both ambient noise and speech signals. Thus, digital noise reduction algorithm should be turned off and microphone should be sensitive in all direction to suppress tinnitus effectively. Further, prescriptive procedures for hearing aid amplification such as NAL-NL1 (Dillion, 1999) and DSL(i/o) (Cornelisse, Seewald& Jamieson,1995) have been used to provide appropriate amount of amplification based on hearing threshold of individuals to improve speech perception scores. It was noted that DSL i/o gives more gain at low frequency (Cornelisse, Seewald& Jamieson, 1995). Moreover, frequency of ambient noise concentrates at low frequency region. Taking this into consideration Wise (2003) investigated effect of prescriptive formula on tinnitus suppression. It was reported that 80 % of individuals with tinnitus experienced less audible tinnitus when hearing aids were programmed according to the DSL (i/o) v4.0 than to NAL-NL1 prescription. Hence it was recommended to fit the hearing aid with DSL (i/o) prescriptive formula. From literature it is clear that by varying setting in hearing aid suppress the tinnitus.

However, individuals who are fitted with hearing aid having tinnitus suffer more in quiet environment than during conversation. Thus, in present study, hearing aid is programmed in various strategies to investigate relief from tinnitus, especially in quiet condition. In each strategy of hearing aid on acoustic output at the ear canal is objectively recorded using probe tube microphone measurement. In addition, behavioral paired comparison method is utilized to find out best hearing aid strategy suits to provide relief from tinnitus, in quiet condition. It is hypothesized that none of the combination of strategies in hearing aid receive relief from tinnitus.

The experimental studies have proved that in majority of subjects on whom tinnitus audibility was reduced after fitted with hearing aid. This is because hearing aid amplifies speech during conversation effectively masks tinnitus and consequently a qualitative and a quantitative data were collected from them reports benefit from hearing aid on tinnitus relief. However, its effect in quiet condition is questionable. Most of the hearing aid users who self-reported tinnitus is still be perceived in quiet condition. Thus, there is a need to know the best strategy in hearing aid that can increase the ambient noise and provide relief from tinnitus.

Aim of the study

To investigate the best amplification strategy that provides tinnitus relief in a quiet environment.

Objectives

The present study utilized the following objectives in each group to investigate the aim of the study

1. To document the minimum masking level on tinnitus suppression.
2. To find the relation between MML at tinnitus pitch and gain at tinnitus pitch in each strategy of hearing aid.
3. To compare amplification strategies on tinnitus relief using paired comparison method.

Method

A one shot posttest only and randomized repeated measures research design was utilized to study the best program that gives relief from tinnitus in quiet environment.

Participants

A total of 14 participants (Table 1) were involved in the study with the age ranged from 20 years to 80 years. They were classified into three groups: mild (N=4), moderate (N=4) and severe (N=6). These groups were formed based on severity of communication handicap from tinnitus using Tinnitus Handicap Index (THI). Those individuals whose hearing sensitivity range from 26 dB HL to 40 dB HL in 250 Hz to 2 kHz (in octave) and 65 dB HL to 80dB HL in >2 kHz to 8 kHz (in octave) were recruited in the study. All the study participants had sloping sensorineural hearing loss with unilateral or bilateral tinnitus in them. Each participant had normal middle ear status as indicated by type 'A' tympanogram. The selected participants were native speakers of Kannada and none of the participants had experience with hearing aid and had no other complain of neurological, psychological and cognitive problems.

Table : Details of the Participants

Groups	Age(yrs)	Tinnitus pitch	Minimum masking level (SPL)	THI raw scores
Mild	58	6000	92	28
Mild	60	3000	70	28
Mild	56	2000	65	25
Mild	45	750	71	28
Moderate	33	4000	68	55
Moderate	58	2000	80	40
Moderate	52	1000	64	47
Moderate	53	250	64	40
Severe	58	250	74	52
Severe	72	3000	79	65
Severe	33	3000	91	68
Severe	35	3000	74	64
Severe	45	1500	63	68
Severe	48	500	86	76

Test environment

Testing procedure was carried out in a sound treated double room, with the ambient noise levels within permissible limits as recommended by ANSI (1999).

Instrumentation

A calibrated diagnostic two channel audiometer [Inventis Piano] with head phone were used to obtain hearing sensitivity in air conduction mode, tinnitus pitch evaluation, minimum masking level and speech identification score from each participant. In addition, bone vibrator was used to obtain bone conduction threshold. Immittance audiometer (GSI 61 Version 2) was used for evaluation of middle ear status. Receiver in the canal [SORINO X-MINI P] digital hearing aid was used which had options to switch off noise reduction circuit, change the directionality and vary compression thresholds. A hardware HIPRO connected to a personal laptop was loaded with NOAH (v-3) software, particular hearing aid software and WinChap (v-3) (a software control the operation of FONIX 7000 hearing aid analyzer) which were used to program and verify the gain in the RIC hearing aid. Fonix 7000 hearing aid analyzer was used to verify the gain set in hearing aid and also to measure the output and gain of the hearing aid at the level of ear canal ofparticipant test ear of at different program settings.

Procedure

The pure tone thresholds for air conduction at octave frequencies from 250 Hz to 8 kHz were obtained using +10 and -5 dB procedure as specified by Carhart&Jerger (1959). The bone conduction thresholds from 250 Hz to 4 kHz were identified using similar

procedure. One of the lists of phonetically balanced word list developed by Yathiraj and Vijayalakshmi (2005) was presented through headphones. The participants were instructed to repeat the words heard. The number of correctly identified words were counted and converted into percentage.Tympanometry was carried out using 226Hz probe frequency and pressure rate was varied from 200/600 daPa. Ipsilateral and contralateral reflexes were found at 500 to 4 k Hz (in octave) by varying the intensity insteps of 5 dB to notice a minimum change in the compliance of tympanic membrane.

Tinnitus Handicap Inventory

Tinnitus Handicap Inventory developed by Newman, Jacobson and Spitzer (1996) is a qualitative questionnaire in English language which comprised of 25 items. A standardized Kannada version of the test developed by Zacharia, Naik, Sada, Kuniyil and Dwarakanath, (2012) was administered to each participant of study group and each question was rated on a three point rating scale 'yes' as 4, 'sometimes' as 2, and 'no' as zero. The maximum score that can be obtained from this test battery is 100. The scoring pattern are 2-16 slight, 18-36 mild, 38-56 moderate, 58-76 severe and 78-100 catastrophic.

Tinnitus Pitch

To obtain the tinnitus pitch, A standardized procedure by Henry, Jastreboff, Jastreboff, Schechter and Fausti (2002) was adopted. Tinnitus pitch quantifies the frequency of Tinnitus. The procedure included presentation of a tone to each participants in octave frequency ranging from 250 Hz to 8000 Hz. Participants were asked to report whether the tone was too high , low or very low compared to their tinnitus pitch. Each tone was presented at 15 dB SL and was instructed to choose the tone which closely matched to their tinnitus. The pitch at which participant indicated it as same, or the nearest as that of their tinnitus was considered as the tinnitus pitch.

Minimum Masking Level on Suppression of Tinnitus

The minimum level at each frequency masks tinnitus is defined as minimum masking level (MML). A narrow band noise was presented at threshold level at each test frequency (250Hz, 500 Hz, 750Hz, 1000Hz, 1500 Hz, 2000Hz, 3000Hz, 4000Hz, 6000Hz and 8000Hz) and its level was increased in 1 dB step size till it masks the tinnitus. Participants wereinstructed to report the minimum level of noise completely masks the tinnitus. The procedure was repeated three times for the consistency of result. In participants with unilateral tinnitus, narrow band noise was presented in the ear having tinnitus. However, in bilateral tinnitus participants, the ear having louder tinnitus was selected to present external noise. A relative gain as a function of frequency was calculated by taking the difference between MML at each frequency and MML at tinnitus pitch.

Hearing aid output at ear canal from different processing strategy

The participant was seated at 12 inch distance from loudspeaker. The position of loudspeaker was placed at 450azimuth in reference to the test ear having tinnitus. The probe microphone of the Fonix 7000 system was inserted into the ear canal of the participant. The probe tip detached from probe unit to mark 5 mm past the end of the doom of RIC hearing aid. Later the probe tip was attached to probe unit and was inserted into the ear canal till the marking of probe tube was visible at tragal notch. After the insertion of probe tube into the ear canal, levelling was performed. A personal laptop loaded with WinChap (v-3) was connected to the FONIX 7000 hearing aid analyser. This software controls the operation of hearing aid analyzer. A digi speech at 65 dB SPL was presented and the output was measured at different frequencies (250 Hz to 8 k Hz in octave) and the resulting curve termed it as real ear unaided response (REUR).A hardware HIPRO connected to the same personal laptop loaded with hearing aid software to program the Sorino X Mini RIC hearing aid. Prescriptive formula NAL- NL1 at low compression threshold (30 dB SLP) was activated. Further, noise reduction circuit was switched off and directional microphone was disabled. Once the hearing aid was programmed with respect to participants hearing loss, it was fitted without changing the position of probe tip at the ear canal. Real ear aided responses at different frequencies (250 Hz to 8 kHz in ocatve) were measured for digi speech presented at 65 dB SPL.

Finally, instrument automatically calculates real ear insertion response by taking the difference between REAR and REUR at each frequency (250 Hz to 8 kHz in octave). It was ensured that gain of hearing aid at each frequency was almost matched with the prescriptive target. In addition, the gain of the hearing aid was optimized by presenting recorded Ling's six sounds, which were presented sequentially at 65 dB SPL through loudspeaker. Depending upon the response for each Ling sound the gain with respect to the spectrum of each sound was programmed. Further, gain at tinnitus pitch was increased till the ringing sensation was completely masked (P1). Similar procedure was carried out by changing only the compression threshold from 30 dB SPL to 50 dB SPL (P2). The entire procedure was performed by programming the hearing aid using DSL i/o (v-5) prescriptive formula at compression thresholds 30 dB SLP (P3) and 50 dB SPL (P4), respectively.

Rating the amplification processing strategy on suppression of tinnitus using paired comparison method

A paired comparison judgment was used to obtain the best program of hearing aid which gives tinnitus relief. A total of six comparisons (P1, P2, P3 and P4) were made. Each participant was instructed to choose one program which gave best relief from tinnitus against other program by listening to the ambient noise presented at 30 dB SPL delivered through loudspeaker. A best program was selected from a total of six comparisons using Round Robin Tournament format. A preference score of one mark was assigned for the best program. Likewise three trials were performed and it was ensured these six comparisons in each trial were randomized. Finally the number of times each program give relief was noted down.

Statistical analyses

1. Descriptive statistics was carried out to determine the mean and standard deviation of different program preferred by the participants.
2. A non parametric Friedman test was performed to compare the preference program among the four programs.
3. Spearman's correlation was carried out to find the relationship between Minimal Masking Level at tinnitus pitch and gain at the tinnitus pitch in each program.

Results

The aim of the study was to investigate the best amplification strategy that gives relief from tinnitus in a quiet environment. Participants were grouped as mild, moderate and severe groups based on Tinnitus Handicap Index (THI) values. From each group, Minimal Masking Level (MML) was analyzed descriptively. A four programs are P1 (DSL i/0 v -5 at compression threshold of 30 dB SPL), P2 (DSL i/0 v -5 at compression threshold of 50 dB SPL), P3 (NAL-NL1 at Compression Threshold of 30 dB SPL) and P4(NAL-NL1 at Compression threshold of 50 dB SPL) were utilized to select the best program that provides tinnitus relief in a quiet environment using paired comparison method. Further, relation between gain at tinnitus pitch in each program and MML at tinnitus pitch was determined. These data were subjected to statistical analyses using SPSS [Statistical Package for Social Sciences] software of version 17.

Minimum Masking Level

Figures 1, 2 and 3 represents a relative gain plotted as a function of frequency from participants of each group. Black dot represents the pitch of the tinnitus. Over all it was observed that, irrespective of group, at low pitch tinnitus (250 Hz, 500 Hz and 750 Hz) a higher amount of masking level was required to suppress the tinnitus. In addition, participants who had tinnitus at frequencies;1 kHz, 2 kHz and 4 kHz required more level of masking noise required at below and above tinnitus pitch than at tinnitus pitch. Further, it is also found that immediate adjacent frequencies (above and below) near tinnitus pitch required less noise level to suppress tinnitus. However, far frequencies with respect to tinnitus pitch required more level of noise to suppress tinnitus.

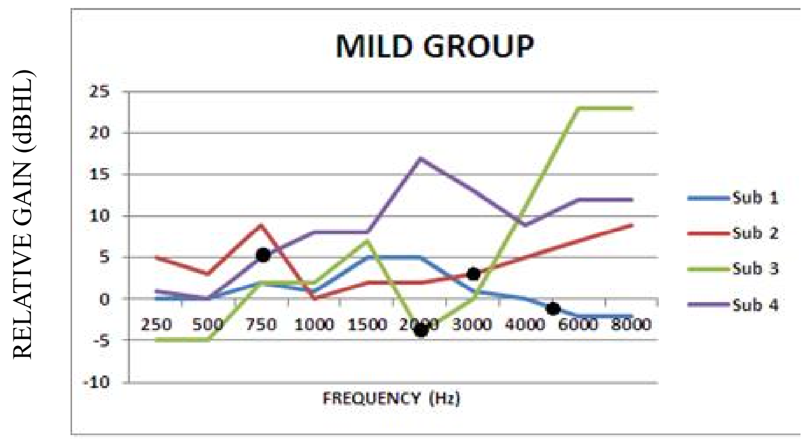

Figure 1. Relative gain as a function of frequency for subjects with mild hearing loss (sub- subject: Sub 1, Sub 2, Sub 3 & Sub 4)

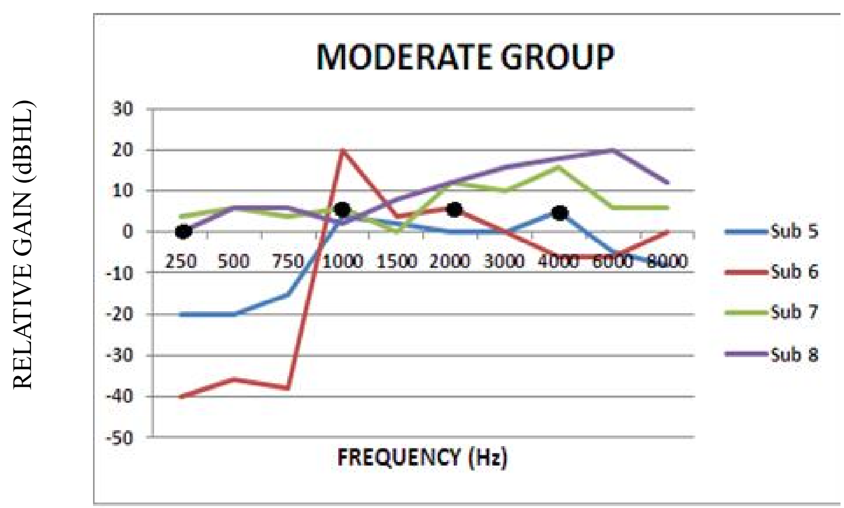

Figure 2. Relative gain as a function of frequency for subjects with Moderate hearing loss (sub- subject:; Sub 5, Sub 6 , Sub 7 & Sub 8)

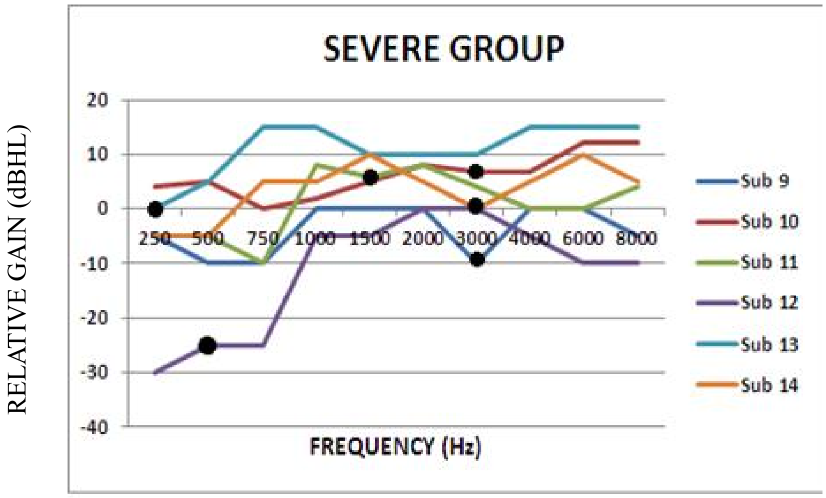

Figure 3. Relative gain as a function of frequency for subjects with severe hearing loss (sub- subject:: Sub 11, Sub 12, Sub 13 & Sub 14)

Relation between MML at tinnitus pitch and gain at tinnitus pitch

Spearman's correlation was performed to measure the correlation between MML at tinnitus pitch and amount of gain provided at each program. A negative correlation was found between MML at tinnitus pitch and gain provided by hearing aid at each program which was found no significantly different in P1(N=14,rs= -1.94, p >.05) , P2 (N=14 rs= -.144 , p >.05), P3 (N=14 rs= -142, p >.05) and P4 (N=14 rs= -.144, p >.05) as represented in figures 4,5,6and7.

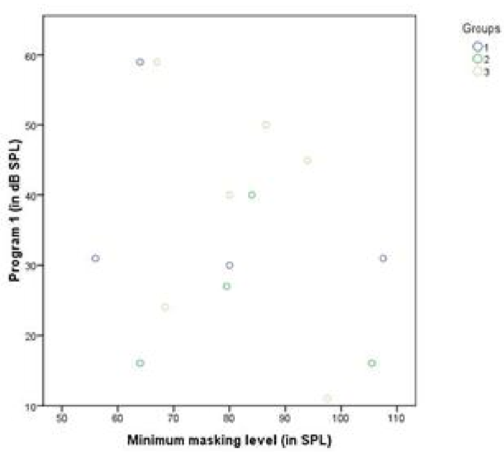

Figure 4. Correlation between MML at tinnitus pitch and gain in P1 at tinnitus pitch (1= mild; 2= moderate; and 3 = severe group)

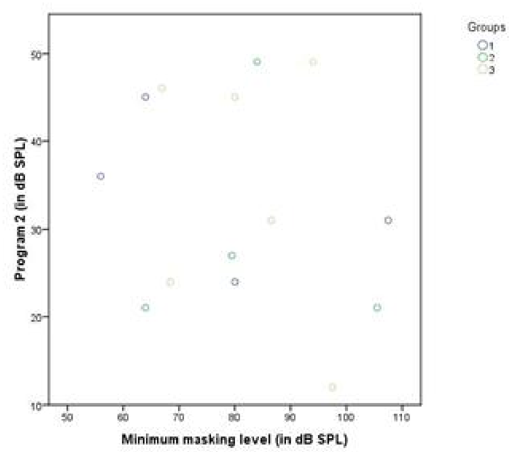

Figure .5.: Correlation between MML at tinnitus pitch and gain in P2 at tinnitus pitch(1= mild; 2= moderate; and 3=severe group)

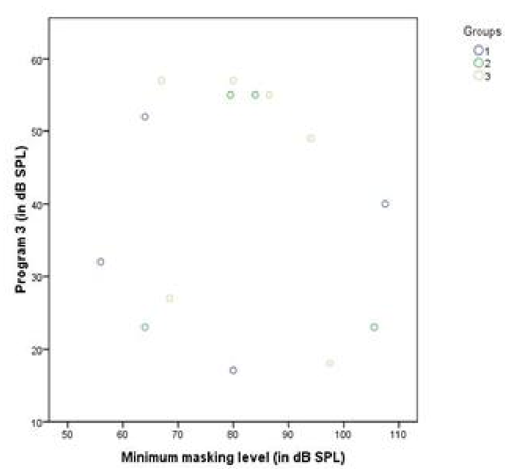

Figure 6. Correlation between MML at tinnitus pitch and gain in P3 at tinnitus pitch (1= mild; 2= moderate; and 3=severe group)

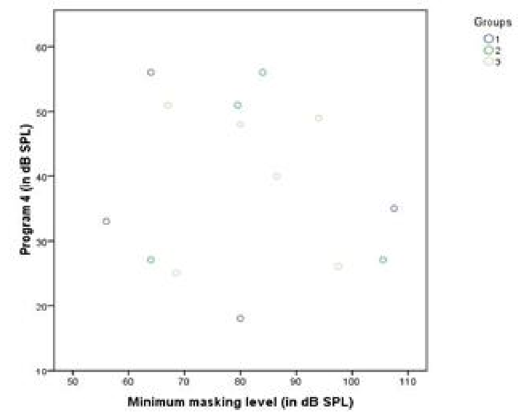

Figure 7. Correlation between MML at tinnitus pitch and gain in P4 at tinnitus pitch(1= mild; 2= moderate; and 3=severe group)

Paired Comparison

Friedman test was performed to compare preference program among four on tinnitus relief from the study participants in each group. Differences in mean preference among the four programs for participants of mild group showed that there was no significant difference [? 2 (3) = 5.750, p > .01]. Similar findings were observed in moderate [? 2 (3) = 3.250 p > .01] and severe groups [? 2 (3) = 3.333 ,p> .01] indicating no significant difference in the mean preference among the four programs.

Preference percentage

The preference of best program on suppression of tinnitus was found by Round Robin tournament. In mild group, out of 4 participants, 25% (1 participant)of them preferred P4 (NAL-NL1 prescriptive formula with a compression threshold of 50dBSPL) and 75% (3 participants) of them preferred P2 (DSL i/o(v-5) compression threshold 50 dBSPL) on tinnitus relief. In moderate group, out of 4 participants, 75% (4 participants) of them preferred P4 (NAL NL1 compression threshold 50 dB SPL)and 25% (1 participant) of them preferred P3 (NAL NL1 compression threshold 30 dB SPL) on tinnitus relief. In severe group, out of 6 participants, 66.7% (4 participants) of them preferred P4 (NAL NL1 compression threshold 50 dB SPL) and 16.7% (2 participants) showed preference to each of P2 (DSL i/o (v-5), compression threshold 50 dB SPL) and P3 (NAL NL1, compression threshold 30 dB SPL) on tinnitus relief, respectively.

Discussion

The aim of the present study was to find the best amplification strategy on tinnitus relief in quiet environment for individuals with sensorineural hearing loss. It was found in each group, three patterns were observed from MML. At high pitch tinnitus, basal part of cochlea exits even in absence of stimulation (phantom perception). For it to suppress, low frequency noise level required was way high. This is because all the participants had minimal to mild hearing loss at low frequency region and it generally stimulates at apical region of cochlea required more level of noise to just mask the tinnitus at high pitch, which exits at basal part of cochlea. In addition, high frequency stimulation above high-pitched tinnitus required high level of noise for it to mask. This could be attributed to more number of outer hair cells damage and consequent loosening of basilar membrane stiffness at basal part of cochlea, which reflected in high frequency hearing loss. Further, high frequency stimulation above high pitch tinnitus excites at basal turn and required high level of noise to suppress tinnitus. At low pitch tinnitus, apical part of cochlea exits in the absence of stimulation. It was found that higher level of masking noise at high frequency was required for it to suppress than at tinnitus pitch. The reason could be loss at high frequencies and presentation of high frequency noise level excites basal turn of cochlea would requires more level of noise to suppress low pitch tinnitus exits at apical region of cochlea. However, tinnitus suppression at mid pitch required higher amount of noise at high frequency than at low frequency. This is because poorer threshold at high frequency exits at basal turn of cochlea required more level for it to suppress the tinnitus, which excites at middle portion of cochlea turn.

In addition, it was found that there was no correlation between MML at the tinnitus pitch and the gain at the tinnitus pitch. This clearly indicates that the loudness of tinnitus and the amount of gain required to obtain tinnitus relief are not directly linked. This is because tinnitus loudness is independent irrespective of hearing loss (Goodwin & Johnson, 1980). However, gain in hearing aid is dependent on degree of hearing loss. These discrepancies perhaps have caused no relation between tinnitus loudness and gain set in hearing aid at tinnitus pitch on tinnitus relief.

In each group, mean preference scores among the four programs showed no significant difference. This could be because in each program the gain was set at tinnitus pitch. That is irrespective of prescriptive formulas in which compression threshold kept at either low (30 dB SPL) or high (50 dB SPL), the ambient noise presented at 30 dB SPL was amplified and provided equal preference on tinnitus relief. The result of mean preference score of the present study is contradictory to the previous research conducted by wise (2003) who reported DSL i/o with low compression threshold provided maximum relief from tinnitus, in quiet environment. This discrepancy between the present study and the research findings of Wise (2003) could be due to methodological concern. In the present study, each program was set in the receiver in the canal digital hearing aid with extended high frequency amplification.

In addition, omni directionality was switch off and DNR was deactivated. Further, each program was optimized such that gain was set at tinnitus pitch. These modifications were common in each program set in hearing aid amplified the ambient noise presented at 30 dB SPL have effectively shown relief from tinnitus. Thus, the effects of prescriptive formula and compression threshold have negligible impact on tinnitus relief.

In preference percentage score of choosing the best amplification, a total of each 75 % of participants in mild (3/4) and in moderate (3/4) group preferred DSL i/o v5 (with CT of 50 dB SPL) and NAL NL1 (with CT of 30 dB SPL) prescriptive formula, respectively, on tinnitus relief. However, in severe group, a total of 66 .6 % (4/6) of participants preferred NAL Nl-1 (with CT of 50 dB SPL) prescriptive formula on tinnitus relief. The exact attributed reason on preference percentage score on tinnitus relief was not known.

A caution must be taken in fitting hearing aid to amplify ambient noise for tinnitus relief. A greater proportion of hearing aid users might achieve tinnitus masking if greater emphasis is placed on amplification of ambient sounds (Searchfield& Tyler, 2006)but this also must be balanced against potential reduction in hearing satisfaction. To conclude, if the subject complains of tinnitus in quiet condition after wearing hearing aid, then option available in it (open fit, directionality off, omnidirection on, wide bandwidth, gain set at tinnitus pitch, either NAL NL-1 or DSL i/o v5 formula, low or high kneepoint) shall be carefully handled to amplify the ambient noise. This can be set as separate program such that it can give a maximum relief from tinnitus especially in quiet condition.

Conclusions

Among the two prescriptive formulas with low and high compression thresholds for tinnitus relief, Participants preference percentage showed a total of each 75 % of participants in mild (3/4) and in moderate (3/4) group preferred DSL i/o v5 (with CT of 50 dB SPL) and NAL NL1 (with CT of 30 dB SPL) prescriptive formula, respectively, on tinnitus relief. However, a total of 66 .6 % (4/6) of participants preferred NAL Nl-1 (with CT of 50 dB SPL) prescriptive formula on tinnitus relief. The exact attributed reason on preference percentage score was not known. The findings infer if hearing aid options which increases ambient noise were selected then effect of prescriptive formula and compression threshold have negative effect on tinnitus relief in quiet environment.

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