

RESEARCH ARTICLE

A comparison between tinnitus retraining therapy and a simplified version in treatment of tinnitus in adults

Hashir Aazh^{1*}, Brian C. J. Moore²

¹- Audiology Department, Royal Surrey County Hospital NHS Foundation Trust, Guildford, United Kingdom

²- Department of Experimental Psychology, University of Cambridge, Cambridge, United Kingdom

Received: 1 Dec 2015, Revised: 24 Dec 2015, Accepted: 25 Dec 2015, Published: 28 Dec 2015

Abstract

Background and Aim: Tinnitus retraining therapy (TRT) comprises comprehensive educational counseling and sound therapy. The aim of this study was to compare the effectiveness of TRT relative to a simplified version of TRT (sTRT). Simplified TRT is different from TRT in the duration and type of the educational counseling (shorter) but is similar to TRT in the application of sound therapy.

Methods: This was a retrospective service evaluation survey and the data were collected from 12 consecutive patients who received TRT and 12 patients who received sTRT. The average duration of tinnitus was six years (SD=7.9) with a range between one month and 30 years. All patients received between three and six months of treatment, which typically involved three to four appointments.

Results: The results showed that scores on the Tinnitus Handicap Inventory (THI) and the visual analog scale of tinnitus loudness, annoyance and effect on life declined significantly (improved) for both TRT and sTRT groups ($p < 0.05$). 75% of the patients receiving TRT and 83% of patients receiving sTRT

exhibited a decline of 25 or more in THI score. The mean decline in the THI scores was 34 (SD=14) for the TRT group, and 41 (SD=21) for the sTRT group, and the difference in means was not statistically significant ($p=0.34$).

Conclusion: The results suggest that the duration and type of counseling does not play a critical role in treatment outcome and sTRT may be used when time constraints do not allow the full treatment.

Keywords: Tinnitus retraining therapy; tinnitus rehabilitation; decreased sound tolerance; hearing disorder

Introduction

Tinnitus retraining therapy (TRT) is a method of treating tinnitus based on the Neurophysiological model proposed by Jastreboff and Hazell [1]. The model is based on the idea that systems outside the auditory pathway are responsible for the severity of tinnitus. Its assumptions are as follows. The initial concerns and conscious thinking of the patient about tinnitus result in activity in both cortical and sub-cortical areas of the brain, including the limbic and autonomic nervous systems. Increased activity of the limbic and autonomic nervous systems can result in increased negative emotions and bodily reactions against the tinnitus. The centers in the brain that are involved are inter-connected and

* **Corresponding author:** Audiology Department, the Royal Surrey County Hospital NHS Foundation Trust, Egerton Road, Guildford, GU2 7XX, United Kingdom. Tel: 0044-1483-571122 ext. 4653, E-mail: hashir.aazh@nhs.net

this can lead to creation of a feedback loop. Increased activity of the emotional centers in the limbic and autonomic systems results in increased attention to and awareness of the tinnitus and this in turn increases the activity of the limbic and autonomic nervous systems. When this happens, the patient is constantly aware of, and distressed by, the tinnitus [2]. According to Jastreboff and Jastreboff, the connections of the various systems in the brain are governed by the principles of conditioned reflexes [2]. Hence, the TRT method is based on the concept of extinction of these reflexes, which is sometimes called habituation. Habituation has been defined as a decrease in response to a benign stimulus when that stimulus is presented repeatedly [3], and from a psychology perspective, extinction of reflexes and habituation are not necessarily the same thing. However, within the context of TRT, the terms are used interchangeably.

TRT is aimed at removing negative associations of the tinnitus signal to enable the natural habituation process to occur. The goal is to achieve this through retraining counseling and sound therapy. Retraining educational counseling is supposed to be a crucial part of TRT; it teaches patients the components of the neurophysiological model of tinnitus and encourages them to reclassify their tinnitus as a neutral signal. Sound therapy is claimed to facilitate tinnitus habituation by decreasing the strength of the tinnitus signal [2]. The TRT protocol requires that the patient adheres to the regimen for 12-24 months, and specifically points out that habituation is a long-term process. However, recent reports suggest that significant improvement usually occurs during the third month following initiation of TRT treatment [4].

Herraiz et al. [5] evaluated the effect of TRT on 158 patients. They provided TRT for 116 cases, partial treatment for 21 patients (patients who refused to wear ear level sound generators or hearing aids but received directive counseling), and no treatment for 21 patients, who stayed on the waiting list. Of the 116 patients in the TRT group, only 68 received retraining counseling

together with sound therapy via instrumentation. The remaining 48 patients were classified as category 0, according to the Jastreboff classification scheme (see below for details) and required only retraining counseling. Scores on the Tinnitus Handicap Inventory (THI) improved by 20 or more points for 68% of patients in the TRT group after one year of treatment. However, for the Visual Analog Scale (VAS) of intensity and annoyance of tinnitus, scores improved by two or more points for only 34% of patients in the TRT group. On average, the THI scores for the TRT group decreased from 48% to 32% and the VAS scores decreased from 6.6 to 5.3 after one year. The TRT group improved significantly more than the group on the waiting list and the group that refused sound therapy when recommended. These results suggest that sound therapy may be of some benefit, but they do not indicate whether the counseling aspect of the TRT is important for success.

Henry et al. [6] conducted a clinical trial to compare the efficacy of TRT and tinnitus masking (TM), using 123 patients, who were randomly assigned to the TM group (59 patients) or the TRT group. The TRT counseling used in their study was the formal structured educational counseling based on seminars given by Jastreboff in the USA. Tinnitus masking counseling was informal and variable but mainly focused on the effective use of sound for providing a sense of immediate relief from the tinnitus. The counseling part of the TM treatment included: 1) reassurance, 2) basic principles for preventing exacerbation of tinnitus, 3) relationship between hearing loss and tinnitus, and 4) reducing stress. Patients in the TRT group were instructed to adjust the output of their ear level sound generators to a level that enabled them to hear both the tinnitus and the noise of the generator. However, for the TM group, the output of the ear level sound generator was essentially chosen by the patient and complete masking was the recommended choice. Also, the TRT group were asked to wear the ear level generators at least eight hours per day, while the TM group were not required to

wear their devices consistently throughout the day. Thus, the two groups differed both in the type of counseling they received and in the sound therapy that they received. The TM patients received 14 hours of total clinician contact while the TRT patients received about 15.5 hours of clinician contact over a period of 18 months. Both TRT and TM groups showed decreases in tinnitus handicap and severity, but the decrease was greater for the TRT group than for the TM group, especially for patients who had a severe problem with tinnitus at the start of the study. It is unclear whether the better results for the TRT group resulted from the difference in counseling, the difference in sound therapy, or both, between the two groups.

Given the time constraints, in the majority of audiology departments in the UK National Health Service (NHS) patients are offered a simplified version of TRT (sTRT) [7,8]. This is different from TRT in counseling (shorter in duration) but is similar to TRT in the application of sound therapy [7].

The aims of this study were: 1) To compare the effectiveness of TRT with that of sTRT in the treatment of tinnitus. We aimed to determine whether retraining counseling is critical to the success of TRT, as has been claimed [1]. 2) To determine the extent to which the success of the tinnitus treatment is affected by the duration of tinnitus, age, presence of hearing loss, and decreased sound tolerance.

Methods

This was a service evaluation retrospective study, comparing outcomes between patients who received TRT and those who received sTRT.

Patients and sample size

Data from 24 patients experiencing tinnitus (aged between 25-79 years old) were assessed for this study. None of the patients had any previous treatment for tinnitus. The average duration of tinnitus was six years (SD=7.9) with a range between one month and 30 years. Seventeen patients had a hearing loss (pure tone average, PTA, for frequencies of 0.5, 1, 2 and 4

kHz more than 20 dB for at least at one ear) and seven patients had normal hearing. Among the cases with hearing loss, seven were hearing aid users and ten had never had hearing aids. All patients were referred from the Otolaryngology Department to the Audiology Department at Ealing Hospital in order to receive tinnitus therapy and auditory rehabilitation. They had been in the waiting list from one to three months. The first 12 patients attending the tinnitus clinic underwent TRT. The other 12 patients received sTRT.

Tinnitus retraining therapy

All patients in the TRT group received retraining counseling, which included teaching about the physiology of the auditory system, the basic principles of brain function with focus on the mechanisms of perception, attention and emotions, the role of the autonomic nervous system, and the mechanism behind creating and retraining conditioned reflexes using the Jastreboff and Hazell neurophysiological model [9].

In the first TRT session, general information related to tinnitus was gathered using the TRT structured interview form [9]. A case history was obtained and otoscopy was performed for all patients. Pure tone thresholds were measured in a sound-attenuating room following the British Society of Audiology recommended procedure [10]. The severity of hearing loss was categorized based on the values of the PTA as recommended by the British Society of Audiology [10]: mild (20-40 dB HL), moderate (41-70 dB HL), severe (71-95 dB HL) and profound (>95 dB HL). Patients with PTAs better than 20 dB were classified as "Better than 20 dB".

Loudness discomfort levels (LDLs) were measured at 0.25, 0.5, 1, 2, 4, 6 and 8 kHz following the TRT protocol [9]. Decreased sound tolerance (DST) was considered as present when average LDLs were 90 dB HL or lower and the patient complained about loud noises. DST is an umbrella term encompassing the experience of hyperacusis and other forms of sound intolerance which is used in the

Table 1. Initial (I) and final (F) THI scores for each patient who received TRT. The table also shows the Jastreboff category for each patient, and gives information about the ear(s) in which the tinnitus was heard, the duration of tinnitus, whether they had a hearing loss, and the type of sound therapy that they received.

Patient	THI(I)	THI(F)	Category	Ear(s)	Duration	Hearing loss	DST	Hearing aids	WSG/SG
1	56	16	1	L&R	4 yrs	Better than 20 dB	No	No	Both
2	36	18	1	L&R	30 yrs	Better than 20 dB	No	No	SG
3	64	20	1	L	4 mo	Better than 20 dB	No	No	Both
4	56	30	1	L&R	3 yrs	Better than 20 dB	No	No	SG
5	97	48	2	L&R	6 yrs	Moderate Bilat.	No	Bilat.	SG
6	40	8	2	L&R	3 yrs	Moderate Bilat.	No	Bilat.	SG
7	36	20	2	L	2 yrs	Mild Bilat.	No	L only	No
8	54	44	2	L&R	4 mo	Moderate (R only)	No	R only	SG
9	70	34	2	L&R	1 yr	Mild Bilat.	No	Bilat.	SG
10	58	22	3	L&R	6 mo	Better than 20 dB	Yes	No	Both
11	62	4	3	L	1 yr	Mild Bilat.	Yes	No	SG
12	78	38	3	L	1 mo	Better than 20 dB	Yes	No	Music at night

THI; tinnitus handicap inventory, DST; decreased sound tolerance, WSG; wearable sound generators using completely open fittings, SG; bedside/table top sound generators or sound pillow

context of TRT [11]. Patients were assigned to one of the five TRT categories on the basis of the severity and duration of their tinnitus, the presence and extent of DST, hearing impairment and prolonged exacerbation of symptoms following sound exposure, as described by Jastreboff and Jastreboff [2].

The specific treatment strategy that was applied to patients in the different categories is described below:

1) Patients in category 0 experience weak or short-lasting tinnitus that has little impact on everyday life. No patients fell in this category.

2) Category 1 includes patients with bothersome tinnitus, but no hearing loss and no DST. There were four patients in this category. The treatment protocol for this group involved directive counseling, advice on sound enrichment and the offer of fitting of bilateral wearable sound generators (WSG), using completely open fittings (Oticon Comfort tips or

skeleton open molds). Two of the patients agreed to wear the WSGs but two preferred not to use the WSGs, stating that environmental noises heard during the day time and a bedside/table top sound generator (SG) at night would be enough for them. Those who agreed to have WSGs were instructed to set the volume so that they could hear both the tinnitus and the noise generated by the device.

3) Patients in category 2 have tinnitus and hearing loss. There were five patients in this category. The treatment for this group involved directive counseling, advice on sound enrichment and the fitting of digital hearing aids. Most patients were bilaterally fitted; see Table 1 for details. For all patients in this category, digital hearing aids were fitted free under the UK National Health Service, following the guidelines provided by the manufacturers and using open fittings or skeleton ear molds with venting as appropriate

for the ears with hearing loss. Real-ear measurements were used to check that the fittings met the NAL-NL1 target [12] and to make adjustments where necessary [13,14].

4) Patients in category 3 complain about loud noises and exhibit DST, with or without tinnitus or hearing loss. There were three patients in this category. Treatment for this category comprised directive counseling with more emphasis on DST, advice to use bilateral WSGs and instructions to set the volume of the WSGs at a level that avoided discomfort while making the WSG noise audible in the presence of background environmental noises (instructions were to increase the volume in noisy environments). Initially, the therapy is focused on the DST and after the patient shows improvement in DST, the tinnitus is addressed more directly. One patient agreed to use WSGs but the other one did not want to do so. For the remaining patient in this category, although she had a mild hearing loss (PTA=22 dB HL) and DST she did not have any perceived hearing handicap or disability as assessed by the Glasgow Hearing Aid Benefit Profile [15]. Therefore, she was not fitted with a hearing aid and she did not want to have WSGs either.

5) Category 4 includes patients experiencing DST and tinnitus with exacerbation of symptoms for a prolonged period of time as a result of noise exposure. No patients fell into this category.

Simplified tinnitus retraining therapy

In the first sTRT session, after taking a general medical history and performing otoscopy, audiometric thresholds and LDLs were measured in the same way as for TRT. The TRT formal interview form was not used for sTRT. The counseling component of the sTRT was based on explanation of the nature of tinnitus and how to manage it. Its aims were: 1) to reassure patients that the annoyance from their tinnitus would gradually reduce with the passage of time following the natural process of habituation; 2) to inform them that reduction in annoyance and distress caused by the tinnitus would promote habituation to the tinnitus and

reduction of the tinnitus itself; 3) in cases of tinnitus combined with hearing loss to explain to them that if they could not hear properly, this was most likely because of their hearing loss and not the tinnitus; 4) to advise them to avoid silence by using sound enrichment. This counseling was repeated in every session.

Although sTRT counseling has some similarities to TRT retraining counseling, it was different from TRT in the following ways: 1) there was no teaching about basic functions of the auditory system; 2) there was no presentation of the basics of brain function and the interactions of various systems of the brain; 3) there was no explanation of the theoretical basis of habituation based on the Jastreboff neurophysiological model; 4) the duration of the initial sTRT counseling was 30 minutes in comparison to 90 minutes for the initial TRT directive counseling.

Sound therapy for sTRT was the same as for TRT. In the sTRT group, five patients had hearing loss and had used hearing aids for a few years. For these cases, more advice was given on using the aids and on sound enrichment using SG. Four patients had hearing loss but had not used hearing aids before. In those cases, digital hearing aids were fitted in the same way as described for the TRT group (see Table 2 for details) and advice was given on sound enrichment using SGs. One patient had normal hearing. In this case, WSGs were fitted bilaterally using open fitting molds, as described for the TRT group. He was also advised on sound enrichment using SGs. Two patients had DST and hearing loss. For these two cases WSGs were fitted using open molds for a one-month period and the patients were advised on sound enrichment using SGs. Following the one-month period, hearing aids were fitted.

Outcome measurement

Two self-report outcome measurement tools were used: the Tinnitus Handicap Inventory (THI) [16] and the Visual Analog Scale (VAS) [17] of tinnitus loudness, annoyance and effect on life. The THI has 25 items, and response choices are “no” (0 point), “sometimes” (2

Table 2. Initial (I) and final (F) THI scores for each patient who received sTRT. The table also shows the Jastreboff category for each patient, and gives information about the ear(s) in which the tinnitus was heard, the duration of tinnitus, whether they had a hearing loss, and the type of sound therapy that they received.

Patient	THI(I)	THI(F)	Category	Ear(s)	Duration	Hearing loss	DST	Hearing aids	WSG/SG
1	90	18	1	L&R	2 yrs	Better than 20 dB	No	No	Both
2	14	6	2	L&R	6 yrs	Moderate Bilat.	No	Bilat.	No
3	64	48	2	L	20 yrs	Moderate Bilat.	No	Bilat.	SG
4	54	28	2	L	20 yrs	Moderate Bilat.	No	L only	SG
5	44	18	2	L&R	8 yrs	Mild Bilat.	No	No	SG
6	48	8	2	L&R	3 yrs	Moderate Bilat.	No	Bilat.	SG
7	58	8	2	L&R	16 yrs	Moderate Bilat.	No	Bilat.	SG
8	94	32	2	L&R	1 yr	Moderate Bilat.	No	Bilat.	SG
9	40	6	2	L&R	9 mo	Moderate Bilat.	No	Bilat.	SG
10	16	6	2	L&R	3 yrs	Moderate Bilat.	No	No	SG
11	64	24	3	L&R	6 yrs	Moderate Bilat.	Yes	No	WSG
12	72	12	2	R	6 yrs	Moderate Bilat.	Yes	R only	WSG in L + SG

THI; tinnitus handicap inventory, DST; decreased sound tolerance, WSG; wearable sound generators using completely open fittings, SG; bedside/table top sound generators or sound pillow

points) and “yes” (4 points). The overall score ranges from 0 to 100. VAS scores are ratings on a scale from 0 to 10. The VAS score for loudness of tinnitus was assessed by asking the patient to rate the loudness of tinnitus during their waking hours over the last month (It was explained that 0 corresponds to no sound being heard and 10 is as loud as a gunfire). The VAS score for annoyance induced by the tinnitus was assessed by asking the patient to rate their subjective perception of annoyance on average during the last month (It was explained that 0 corresponds to no annoyance and 10 is the most annoying thing that can possibly happen). The VAS score for the impact of tinnitus on their life was assessed by asking the patient to rate the effect of tinnitus on their life during the last month (It was explained that 0 corresponds to no effect and 10 is as big as an earthquake).

The THI and VAS questionnaires were completed by the patients at their first

assessment session (pre-treatment) and after 4-6 months of therapy, which typically involved 3-4 appointments (post-treatment).

Clinician and clinical contact time

A single specialist administered the treatment for all patients. He was clinically certified as an audiologist and had special expertise in the treatment of tinnitus and hyperacusis. Each patient was seen at three to four clinical appointments over a period of four to six months. The TRT patients received an average of almost 5 hours of total audiologist contact time while the sTRT patients received about 2.5 hours. This excludes the assessment session, which usually took about an hour for PTA, LDLs, case history and the baseline questionnaires for both TRT and sTRT.

Data analysis

Participants' age, gender, pure tone audiogram,

Table 3. Mean and standard deviation of the THI and VAS scores before and after 4-6 months of TRT and sTRT treatments, and the results of t-tests assessing the significance of the differences between pre- and post-treatment scores. Two patients in the sTRT group and one patient in the TRT group did not complete the VAS questionnaire.

Group		THI Mean (SD)	VAS loudness Mean (SD)	VAS annoyance Mean (SD)	VAS effect on life Mean (SD)
TRT	Pre	59 (18)	5.6 (1.8)	7.0 (2.1)	6.2 (2.0)
	Post	25 (14)	3.9 (1.7)	3.8 (2.2)	3.0 (2.3)
	p	<0.001	<0.05	<0.001	<0.01
sTRT	Pre	55 (25)	5.3 (1.5)	4.8 (2.1)	5.1 (2.3)
	Post	14 (10)	3.8 (1)	1.9 (2.5)	1.1 (1.8)
	p	<0.001	<0.01	<0.01	<0.001

THI; tinnitus handicap inventory, VAS; visual analog scale, TRT; tinnitus retraining therapy, sTRT; simplified tinnitus retraining therapy

LDLs, duration of tinnitus and scores on THI and VAS were imported from the records held in the electronic database of the Audiology Department. The data were anonymised prior to statistical analysis. Group differences between TRT and sTRT were assessed using t-test and chi-square test. Pearson correlation was used in order to assess the association between improvement in tinnitus handicap and other patient variables. The p value required for statistical significance was set at $p < 0.05$. The STATA programme was used for statistical analyses.

Results

Decline in THI scores after 4-6 months of treatment

Tables 1 and 2 show the individual THI scores, before and after 4-6 months of TRT or sTRT treatment. The tables also show the Jastreboff treatment categories and the type of sound therapy used for each patient. Scores declined for every patient in each group, indicating a decrease in the subjective tinnitus handicap. Four patients who received TRT [2,4,11,12] and two patients who received sTRT [5,10] decided not to wear WSGs or hearing aids despite being recommended to do so. They stated that the

effects of environmental noises at day time and SGs at night were sufficient to make their tinnitus manageable. The mean decline of THI scores for these six patients was 30 (SD=17), which was only a little less than the mean decline of 40 (SD=18) of the THI scores for the remaining 18 patients who did use hearing aids and/or WSGs as a part of their treatment. Based on an unrelated-samples t-test, the difference between the mean declines was not significant ($p = 0.234$). The mean ratio of final to initial THI scores, which might be regarded as a better measure of the effectiveness of the treatment, was 0.39 (SD=0.6) for the six patients who decided not to wear WSGs or hearing aids and 0.33 (SD=0.6) for the remaining eighteen patients. The relative improvement produced by the treatment was only a little less for those who decided not to wear WSGs or hearing aids than for those who did, and the difference just failed to reach the 0.05 level of significance ($p > 0.05$). The mean THI scores for each group before and after treatment are shown in Table 3. Paired-sample t-tests (outcomes shown in Table 3) showed that THI scores declined significantly for both groups. Seventy five percent of patients receiving TRT and 83% of patients receiving sTRT exhibited a decline of 25 or more in THI score. The mean decline in the THI scores was

34 (SD=14) for the TRT group and 41 (SD=21) for the sTRT group, and the difference in means was not statistically significant ($p=0.34$). The mean ratio of final to initial scores was also similar for the two groups, and did not differ significantly.

Improvement in VAS scores after 4-6 month of treatment

As shown in Table 3, the VAS scores for tinnitus loudness, annoyance and effect on life improved significantly for both groups. 42% of patients receiving TRT and 50% of patients receiving sTRT exhibited a decline of tinnitus loudness of 2 or more points. The mean decline in tinnitus loudness was 1.7 (SD=1.9) for the TRT group and 1.5 (SD=1.0) for the sTRT group, and the difference was not statistically significant ($p=0.74$). 75% of patients receiving TRT and 58% of patients receiving sTRT exhibited a decline of annoyance of tinnitus of 2 or more points. The mean decline in annoyance of tinnitus was 3.2 (SD=2.3) for the TRT group and 2.9 (SD=2.8) for the sTRT group, and the difference was not statistically significant ($p=0.80$). 67% of patients receiving TRT and 75% of patients receiving sTRT exhibited a decline in the effect of tinnitus on life of 2 or more points. The mean decline was 3.3 (SD=2.6) for the TRT group and 4.0 (SD=1.8) for the sTRT group, and the difference was not statistically significant ($p=0.46$).

For the six patients who decided not to use WSGs or hearing aids, the mean decline in VAS scores was 2 (SD=2) for tinnitus loudness, 3.8 (SD=2.5) for annoyance, and 4.3 (SD=2) for effect on life. These declines were not significantly different from those found for the remaining patients who did use hearing aids and/or WSGs as a part of their treatment, which were 1.5 (SD=1.3) for loudness, 2.7 (SD=2.5) for annoyance, and 3.3 (SD=2) for effect on life.

Relation between decline in THI score and age, duration of tinnitus, hearing loss, and decreased sound tolerance

The decline in THI score was significantly correlated with age ($r=0.42$, $p<0.05$). Older

patients showed greater declines in THI scores than younger patients. The decline in THI scores was not significantly correlated with the self-reported length of time the patient had tinnitus ($r=-0.034$, $p=0.89$) and there was no statistically significant difference between the improvement in the mean THI scores for patients with and without hearing loss ($p=0.87$). There was no statistically significant difference between the improvement in THI scores for patients with and without DST ($p=0.19$).

Discussion

TRT in comparison with sTRT

There was no statistically significant difference in the effectiveness of TRT and sTRT as determined using THI scores and VAS scores of tinnitus loudness, annoyance and effect on life. Educational retraining counseling is generally regarded as an important component of TRT. The counseling is intended to explain the (presumed) mechanisms underlying the tinnitus and to remove negative associations with the tinnitus. This is regarded as important for allowing habituation to the tinnitus to occur [17]. The sTRT counseling used here was different from TRT counseling. In sTRT, counseling did not include any teaching about the interactions of various systems of the brain, there was no explanation of the Jastreboff neurophysiological model, and the duration of the initial sTRT counseling was only 30 minutes. This contrasts with the 90 minutes of initial TRT counseling. While the counseling differed between the two groups, the sound therapy used for the two groups was essentially the same. The fact that outcomes were very similar for the two groups suggests that the specific counseling used with TRT is not of critical importance.

The patients in our study received therapy for only four to six months. Henry et al. [6] reported that patients receiving TRT continued to improve over up to 12 to 18 months of treatment, while for the alternative treatment of TM, most of the improvement was observed during the first three to six months. It is possible

that differences in effectiveness of TRT and sTRT would emerge if the therapy continued over a longer period. This remains to be tested.

Comparison to other studies

The improvements in tinnitus handicap observed in this study are comparable to those found by Tyler et al. [18], who reported that for patients who received TRT the average decrease in tinnitus handicap was 32% after 12 months. However, the mean decline in THI scores found in our study for both the TRT and sTRT groups was considerably greater than found in studies conducted by Herraiz et al. and Henry et al. [5,6]. Herraiz et al. reported that the mean decline in THI scores after six months was about 14, while Henry et al., reported a mean decline in THI scores of about 15 after six months of TRT treatment for patients who started with a severe tinnitus problem [5,6]. The cause of the greater mean effect in our study is not clear. It might reflect individual differences in the patients, differences in the way that patients were selected for inclusion in the studies, or individual differences in the clinicians' personality and attitude.

Our results suggest that the duration of tinnitus, and the presence of hearing loss and DST are not associated with the outcome of the tinnitus treatment. The first two findings are consistent with the results of Henry et al. [6] who also showed that the duration of tinnitus and the presence or absence of hearing loss were not associated with the outcome of tinnitus treatment (TRT or TM).

Herraiz et al. [5] reported that THI scores were significantly reduced (improved) following treatment for the TRT group, but that the patients in the partial treatment group, who refused to use hearing aids or WSGs, did not show this decrease. However, in our study, the four patients in the TRT group who decided not to use WSGs or hearing aids showed declines in THI scores similar to those for the patients who did use WSGs and/or hearing aids (see Table 1). Our results are not consistent with those of Henry et al. [6], but they are consistent with the claim of Herraiz et al. [5] that TRT can be

effective even if patients reject instrumentation.

Study limitations

This study was a service evaluation survey that was not designed to assess the efficacy of treatments, for which a randomized controlled design is required [19]. Therefore, future studies should adopt a randomized controlled design in order to compare the efficacy of TRT and sTRT. It is noteworthy that none of the 24 patients in the two groups of the present study dropped out. Nevertheless, the number of participants was relatively small for this type of study and the limited sample size may have influenced the outcome. The effect of small sample size is more pronounced for subgroup analysis [20]. Therefore, our results concerning the differences in treatment outcome among patients with/without hearing loss, with/without DST, and with/without use of WNGs, hearing aids, or SGs should be interpreted with caution.

Another weakness of this study and of several previous studies evaluating the efficacy of different forms of tinnitus therapy, is that several possible control groups were omitted.

Examples of such groups are:

- 1) A group that received comparable attention from and time with a specialist, but who received only sympathy and general reassurance that their tinnitus was not dangerous or life-threatening.
- 2) A group that received sound therapy using WSGs, SGs and/or hearing aids, but without any counseling apart from instructions in using the devices.
- 3) A group that was simply briefly interviewed by a specialist at intervals of, say, one month, to assess the severity of their tinnitus, but who received no counseling or sound therapy.

The results from these three control groups, together with results from the TRT and sTRT groups, would help to determine the extent to which the decline in tinnitus handicap depends on the amount and form of the counseling and on the use of sound therapy devices such as WSGs or SGs.

Conclusion

The effectiveness of full TRT was compared with that for a simplified version (sTRT). The two forms of therapy were similar in the sound therapy that was employed, but differed in the duration and type of counseling. The THI and VAS scores declined (improved) significantly over a period of four to six months for both TRT and sTRT with no significant between-group differences. These results indicate that the specific form and duration of the counseling is not a critical factor in determining the outcome of tinnitus therapy. The sTRT may be used in tinnitus rehabilitation when time constraints do not allow for the application of the full treatment.

REFERENCES

- Jastreboff PJ, Hazell JW. A neurophysiological approach to tinnitus: clinical implications. *Br J Audiol.* 1993;27(1):7-17.
- Jastreboff PJ, Jastreboff MM. Tinnitus retraining therapy for patients with tinnitus and decreased sound tolerance. *Otolaryngol Clin North Am.* 2003;36(2):321-36.
- Kandel ER, Schwartz JH, Jessel TM. *Principles of Neural Science.* 4th ed. New York: McGraw-Hill; 2000.
- Jastreboff PJ. 25 years of tinnitus retraining therapy. *HNO.* 2015;63(4):307-11.
- Herraiz C, Hernandez FJ, Plaza G, de los Santos G. Long-term clinical trial of tinnitus retraining therapy. *Otolaryngol Head Neck Surg.* 2005;133(5):774-9.
- Henry JA, Schechter MA, Zaugg TL, Griest S, Jastreboff PJ, Vernon JA, et al. Outcomes of clinical trial: tinnitus masking versus tinnitus retraining therapy. *J Am Acad Audiol.* 2006;17(2):104-32.
- Aazh H, Moore BCJ, Glasberg BR. Simplified form of tinnitus retraining therapy in adults: a retrospective study. *BMC Ear Nose Throat Disord.* 2008;8:7.
- Department of Health. Provision of services for adults with tinnitus: a good practice guide. London: UK Department of Health; 2009.
- Jastreboff PJ, Hazell JWP. *Tinnitus retraining therapy: implementing the neurophysiological model.* 1st ed. New York: Cambridge University Press; 2004.
- British Society of Audiology. *Pure tone air and bone conduction threshold audiometry with and without masking and determination of uncomfortable loudness levels.* 2004.
- Aazh H, McFerran D, Salvi R, Prasher D, Jastreboff M, Jastreboff P. Insights from the First International Conference on Hyperacusis: causes, evaluation, diagnosis and treatment. *Noise Health.* 2014;16(69):123-6.
- Dillon H. NAL-NL1: a new procedure for fitting non-linear hearing aids. *Hear J.* 1999;52(4):10,12,14,16.
- Aazh H, Moore BCJ. The value of routine real ear measurement of the gain of digital hearing aids. *J Am Acad Audiol.* 2007;18(8):653-64.
- Aazh H, Moore BCJ, Prasher D. The accuracy of matching target insertion gains with open-fit hearing aids. *Am J Audiol.* 2012;21(2):175-80.
- Gatehouse S. A self-report outcome measure for the evaluation of hearing aid fittings and services. *Health Bull (Edinb).* 1999;57(6):424-36.
- Newman CW, Jacobson GP, Spitzer JB. Development of the Tinnitus Handicap Inventory. *Arch Otolaryngol Head Neck Surg.* 1996;122(2):143-8.
- Huskisson E. *Visual analogue scales. Pain measurement and assessment.* New York: Raven Press; 1983.
- Tyler RS, Noble W, Coelho CB, Ji H. Tinnitus retraining therapy: mixing point and total masking are equally effective. *Ear Hear.* 2012;33(5):588-94.
- Pocock SJ. *Clinical trials: a practical approach.* 1st ed. Chichester: Wiley; 1983.
- Vandenbroucke JP, von Elm E, Altman DG, Gøtzsche PC, Mulrow CD, Pocock SJ, et al. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration. *PLoS Med.* 2007;4(10):e297.