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The Effect of a New Treatment Based on Somatosensory Stimulation in a Group of Patients with Somatically Related Tinnitus

David Homayoun Latifpour,[1] Jan Grenner,[2] and Catharina Sjödahl[1,3]

[1] *Department of Health Sciences, Division of Physical Therapy, Lund University, and* [2] *Ear, Nose, and Throat Department and* [3] *Department of Psychiatry–Landskrona, Lund University Hospital, Lund, Sweden*

Abstract: The aim of this study was to evaluate the effect of a new treatment consisting of stretching, posture training, and auricular acupuncture immediately and at a 3-month follow-up. This method has not been tested previously. From an original pool of 41 potential subjects, we recruited 24 (12 men, 12 women; ages 18–70 years) into this study and divided them from a waiting list into either a treatment group or a control group. We measured mobility of neck and posture; measured severity of tinnitus by the Klockhoff test and the visual analog scale (VAS); and measured grade of anxiety and depression with the Hospital Anxiety and Depression Scale. We also used the Mann-Whitney U-test to determine statistical significance. The statistical analysis demonstrated a significant decrease of tinnitus in the treatment group as compared with the control group, according to the VAS before and after treatment ($p < .001$) and at follow-up after 3 months ($p < .01$). We also observed a significant decrease of tinnitus according to the Klockhoff test before and after treatment ($p < .001$) and at follow-up after 3 months ($p < .01$). Our study indicates that this method, based on somatosensory stimulation, may be a useful and alternative treatment of somatic tinnitus.

Key Words: physiotherapy treatment; somatosensory stimulation; tinnitus

Tinnitus is a multifaceted symptom with a variety of causes (otological, neurological, metabolic, pharmacological, vascular, musculoskeletal, and psychological), several of which often occur in the same patient [1]. Despite the fact that tinnitus is often seen in connection with hearing impairment, not all patients have impaired hearing. A correct diagnosis is therefore important, as is understanding the reason why tinnitus has become a problem for the patient [2]. Somatically related tinnitus should be considered a subgroup of tinnitus. Studies have established that disorders of the somatosensory system of the upper cervical region and head can aggravate tinnitus. Dysfunction of the head and upper-neck region can cause tinnitus via activation of the somatosensory system. Strong muscle contractions of the head and neck can modulate the tinnitus perception of 80% of tinnitus patients and elicit a sound perception in 50% of people without tinnitus.

These somatic phenomena are equally spread among people with or without a disorder of the cochlea [3]. A clear connection can be seen between jaw disorders, neck pain, headache, and tinnitus. There could also be a connection between nerve impulses from the back of the neck and head through multisynaptic connections in the brainstem and cochlea. Some tinnitus patients share several clinical descriptions of tinnitus without necessarily having other hearing problems [4]. Because there is a connection between pitch and loudness and somatic stimulation, pitch and loudness (as external stimuli) are capable of influencing somatic stimulation. These phenomena and the connection between tinnitus and somatic neural disorders indicate that a neural connection between the somatosensory and the auditory systems may be important in tinnitus.

Anatomical and physiological evidence support these observations. The trigeminal and dorsal root ganglia

Reprint requests: David H. Latifpour, MMSci, RPT, Uardavagen 3, 224 71 Lund, Sweden. Phone: +46 707 233519; E-mail: latifpour@hotmail.com

transfer afferent somatosensory information from the periphery to secondary sensory neurons in the brainstem. These structures send excitatory projections to the cochlear nucleus [5]. Moreover, the cochlear nucleus innervates parts of the trigeminal, ophthalmic, and mandibular nuclei [6]. Signals from the trigeminal supply the hearing system in the cochlear nucleus, superior olivary nucleus, and inferior colliculus [7]. Extensive fluctuating tinnitus indicates somatic factors such as fluctuating hearing, bruxism, or head and neck muscle tension [8]. One common picture is somatic injuries or illnesses in the head or back of the neck, ipsilateral tinnitus, absence of vestibular sign, or neurological problems. Affected patients also have a clear tone of tinnitus that is symmetrical to both ears [4].

A combined treatment has been developed by one of the authors (DHL). It is based on clinical experience in the treatment of tinnitus and focuses on somatosensory causes such as muscle tension, muscle dysfunction, and impaired mobility in neck and jaw and their implications for tinnitus. The aim of this study was to evaluate the effect of group therapy with a new physiotherapy method consisting of stretching, posture training, and auricular acupuncture (SPA) in patients with somatically related tinnitus and to evaluate possible remaining effects after 3 months. We have not found that this combination of different treatments (SPA) has been tested previously.

SUBJECTS AND METHODS

Subjects

Somatically related tinnitus was defined as tinnitus not dominated by depression, anxiety, severe hearing loss, impaired hearing, or tinnitus caused by somatic dysfunction and imbalance from upper cervical spine, head, neck, and jaw.

Patients undergoing this treatment also had to have a good understanding of both written and spoken Swedish to avoid any misunderstandings during interviewing and completing questionnaires. We excluded patients who had been treated with physiotherapy for tinnitus during the last 5 years or who had illness and medication known to influence tinnitus. We also excluded tinnitus patients with known mental problems.

We originally entered 41 patients into the study. These patients, whose tinnitus had started within a 10-year period before the start of the study, had been referred to the audiology section of the Ear, Nose, and Throat Department (ENT) in Lund University Hospital by a physician who diagnosed somatically related tinnitus. A physician had asked all patients by phone whether they would be interested in taking part in the study. All of these patients were sent a letter including information regarding the study and how the study and treatment would be carried out. We divided the patients consecutively into one treatment and one control group. The first 22 patients were placed in the treatment group and the latter 19 in the control group. This was done to avoid exceeding the normal waiting time at the audiological section of the ENT department.

In the treatment group, four patients declined participation after having received the written information about the study, and another two never came to the first examination. Sixteen patients started the treatment. Two of them quit after the first session, having believed they would get paid for taking part in the study, and one could attend only five of the nine treatment sessions owing to lack of time and was, therefore, excluded from the study. A total of 13 patients in the treatment group completed the study.

In the control group, 4 patients declined participation after having received the written information regarding the study, and 15 accepted. Two never came to the first examination, and two never completed the examinations. A total of 11 patients in the control group completed the study, along with the 13 in the treatment group, for a total of 24 patients who remained in the study to its end.

Methods

Before treatment, a physician examined the patients regarding medical history and audiogram. A physiotherapist measured the mobility of the neck by Myrin (an inclinometer compass method) [9]. The measurement was performed in a sitting position, and the best value of three was noted in the protocol. A Debrunner's kyphometer was used for measurement of posture [10]. The measurement was performed in a standing position; C7–T12 show the thoracic kyphosis, and T12–L5 measure lumbar lordosis. We also asked the participants to answer questions about their mental health according to the Hospital Anxiety and Depression Scale (HADS) [11] and about severity of tinnitus by the Klockhoff assessment [12]. We used a visual analog scale (VAS) to show the value of severity of tinnitus at the moment of examination. The VAS is a 100-degree scale that is tested for validity and reliability. It is used to describe a subjective valuation of their immediate pain [13]. Patients mark the intensity of their tinnitus inconvenience by a cross on the 100-degree scale: 0 is "no inconvenience" and 100 is "worst inconvenience." The patients did not see the previous evaluation results.

After treatment, we asked all patients to describe in their own words how the SPA method had influenced them. Neither of the examiners had any knowledge of the patient groups. We examined and measured the patients in the treatment group 1 week before and 1 week after the treatment and also 3 months after completed treatment. Those in the control group underwent the same

examinations and measurements as did the treatment group while they were on a waiting list for treatment. The purpose of the control group in this study was to compare the SPA against nontreatment to exclude the self-efficacy (self-healing effect) during the 4 months' duration of the study.

Process of Treatment

Nine treatment sessions were divided into three per week during a 3-week period. One treatment session consisted of three parts and lasted about 60 minutes. Part 1 consisted of stretching of the shoulder, neck, and jaw. The purpose was to accomplish muscle symmetry and reduce tension in the jaw and neck. The muscles concerned were the clavicular and acromial part of the deltoids, the descendens part of the trapezius, the splenius capitis, the levator scapulae, and the sternocleidomastoid. The patients stretched these muscles themselves under the supervision of DHL. The technique of muscle stretching was to stretch the muscles for 10 seconds. The muscles of the jaw, masseter, temporalis, and medial and lateral pterygoid were stretched according to the proprioceptive neuromuscular facilitation technique [14].

Part 2 included rectification of posture aimed at making the patients aware of their bodies but also at retaining the effect of the stretching. The patients themselves also performed this feature actively under the supervision of DHL. The patients were instructed systematically to "scan" their bodies, evaluating each part of the anatomy in succession [15].

Part 3 was auricular acupuncture while in a sitting position for 25 minutes [16]. Four needles were inserted in each ear; the acupuncture points were Helix 7, the kidney, external ear, and internal ear. The purpose was to increase somatosensory stimulation by stimulating the trigeminal nerve and to cause the patients to relax.

We also provided the patients with a home training program, which they were allowed to do once or several times per day if they chose to. The home training was the same training as was performed in the group.

Data Analysis

We calculated descriptive statistics, mean (m), standard deviation (SD), median (md), quartiles (first and third), and range. We used the Mann-Whitney U-test to identify differences between the treatment and control groups and analyzed all data using SPSS (version 14).

Ethics and Conditions

All patients received both written and oral information regarding the aim of the study and how it would be executed and were also told that they could leave the study group at any time without giving any reasons or without suffering any consequences in their future care. Confidentiality was guaranteed. For ethical reasons, the control group received treatment after completion of the study. The Ethics Committee for Caring Sciences at Lund University approved the study.

RESULTS

The demographical data showed a fairly even age distribution between the treatment group (n = 13) and the control group (n = 11). The distribution according to gender was also even, with six men and seven women in the treatment group and six men and five women in the control group. The distribution according to age was 24–68 years (m = 51; SD = 16; md = 57) in the treatment group and 25–66 (m = 50; SD = 13; md = 54) in the control group.

Examination before intervention involving all variables did not show any significant difference between the treatment and control groups, with the exception of the mobility of lateral neck flexion. The treatment group had better mobility concerning lateral flexion as compared with the control group ($p < .05$; Table 1).

Table 1. Description and Comparison of Mobility and Posture in Treatment and Control Groups at Start of Study

Measurements and Questionnaires Before Treatment	Treatment Group (n = 13)			Control Group (n = 11)			Significance Level (p value)
	q1 = 25	md = 50	q3 = 75	q1 = 25	md = 50	q3 = 75	
Mobility of neck flexion and extension	10.40	11.80	12.80	9.20	11.20	13.00	.943
Mobility of neck lateral flexion right and left	7.10	8.70	9.40	6.00	6.20	7.20	.011*
Mobility of neck rotation right and left	11.90	12.90	14.30	10.20	11.80	12.60	.090
Posture C7–T12	25.00	30.00	40.00	23.00	32.00	38.00	.877
Posture T12–L5	16.00	22.00	27.00	15.00	22.00	35.00	.787
Hospital Anxiety and Depression Scale	6.50	10.00	16.00	6.00	10.00	24.00	.831
Klockhoff test	2.00	2.00	3.00	2.00	2.00	3.00	.686
Visual analog scale	50.00	63.00	69.00	37.00	55.00	65.00	0.338

md = median; q1 = quartile 1; q3 = quartile 3.
* Statistically significant ($p < .001$).

Mobility of the Neck

The statistical analysis of mobility did not demonstrate any significant difference between the treatment and control groups. In the treatment group, 11 patients had improved rotation after treatment ($p = .09$), and 7 patients had improved flexion-extension at follow-up after 3 months as compared to pretreatment values ($p = .3$). Eight patients had improved lateral flexion at 3 months' follow-up as compared to pretreatment values ($p = .1$; Table 2).

Posture

The individual analysis of posture demonstrated that 5 of 13 patients (38%) improved the kyphosis (C7–T12) and 7 (54%) improved the lordosis (T12–L5) in the treatment group. The corresponding value in the control group was 3 of 11 (27%) for kyphosis and lordosis (Table 3).

Hospital Anxiety and Depression Scale

The individual statistical analysis demonstrated that in 9 of 13 patients in the treatment group (69%) their HADS score decreased, whereas the score decreased in 3 of 11 patients (27%) in the control group.

Klockhoff Self-Evaluation

According to the Klockhoff scale, we observed significant improvement in the severity of tinnitus in patients in the treatment group as compared with those in the control group, both in posttreatment versus pretreatment outcomes ($p < .01$) and in 3-month follow-up versus pretreatment values ($p < .05$). In 9 of 13 patients (69%), the tinnitus score was reduced to one degree, and in 4 (30%) from third-degree to second-degree tinnitus (Table 4).

Visual Analog Scale

The VAS results demonstrated a decrease in the experience of tinnitus annoyance in the treatment group patients as compared with those in the control group after treatment and before treatment ($p < .001$) and at follow-up after 3 months ($p < .01$; Table 5).

Open Question

The answers to an open question regarding how the patients experienced their health situation after treatment revealed that four patients had better mobility of the

Table 2. Description and Comparison of Pre- and Posttreatment Neck Mobility in Treatment and Control Groups

	Treatment Group (n = 13)					Control Group (n = 11)					Significance Level
Neck Mobility	**m**	**SD**	**q1**	**md**	**q3**	**m**	**SD**	**q1**	**md**	**q3**	**(*p* value)**
Flexion-extension difference pretreatment to posttreatment	0.4	1.5	−0.9	0.1	2	−0.1	1.2	−0.9	0	0.7	.5
Flexion-extension difference pretreatment to 3 months' follow-up	0.6	1.2	0.1	0.8	1.5	0.4	1.1	−0.4	0	0.8	.3
Flexion-extension difference posttreatment to 3 months' follow-up	0.2	1.5	−1	0	0.9	0.4	0.8	−0.2	0.1	1.0	.5
Lateral flexion right-left difference pretreatment to posttreatment	0.1	1.2	−0.7	−0.4	1	0.6	0.8	0	0.5	1.3	.2
Lateral flexion right-left difference pretreatment to 3 months' follow-up	0.2	1.3	−0.8	0.2	1.1	0.9	0.9	0	1	1.4	.1
Lateral flexion right-left difference posttreatment to 3 months' follow-up	0.1	0.9	−0.5	0	0.8	0.3	0.5	0	0.1	0.7	.9
Rotation right-left difference pretreatment to posttreatment	0.5	1.8	−0.6	0.2	2.2	1.1	1.2	0	1	1.8	.5
Rotation right-left difference pretreatment to 3 months' follow-up	0.7	1.8	−0.5	0.2	2.1	1.5	1.2	0.9	1.2	2.4	.09
Rotation right-left difference posttreatment to 3 months' follow-up	0.2	1.3	−0.3	0	1.5	0.4	0.9	−0.2	0	1.0	.9

m = mean; md = median; q1 = quartile 1; q3 = quartile 3; SD = standard deviation.

Table 3. Description and Comparison of Pre- and Posttreatment Posture in Treatment and Control Groups

	Treatment Group (n = 13)					Control Group (n = 11)					Significance Level
Posture	**m**	**SD**	**q1**	**md**	**q3**	**m**	**SD**	**q1**	**md**	**q3**	**(*p* value)**
Thoracic kyphosis (C7–T12) difference pretreatment to posttreatment	−1.8	6.7	−6	2	3	1	6.9	−2	0	7	.6
Thoracic kyphosis (C7–T12) difference pretreatment to 3 months' follow-up	−1.4	7.7	5	0	3.5	2.6	9.2	−5	0	9	.7
Thoracic kyphosis (C7–T12) difference posttreatment to 3 months' follow-up	−0.3	4.3	−3.5	0	3.5	1.6	7.3	−3	0	9	.4
Lumbar lordosis (T12–L5) difference pretreatment to posttreatment	1.4	10	−8.5	2	8.5	−1.5	11.6	−5	−3	2	.5
Lumbar lordosis (T12–L5) difference pretreatment to 3 months' follow-up	3.1	8.2	−3.5	2	9.5	−2.1	9.1	−7	−4	4	.2
Lumbar lordosis (T12–L5) difference posttreatment to 3 months' follow-up	1.2	5.1	−1.5	0	6	−0.6	3.1	−2	0	1	.3

m = mean; md = median; q1 = quartile 1; q3 = quartile 3; SD = standard deviation.

Table 4. Description and Comparison of Pre- and Posttreatment Klockhoff Test Values in Treatment and Control Groups

Klockhoff Three-Degree Scale	Treatment Group (n = 13)			Control Group (n = 11)			Significance Level (*p* value)
	q1	md	q3	q1	md	q3	
Difference pretreatment to posttreatment	−1	−1	0	0	0	0	.009*
Difference pretreatment to 3 months' follow-up	−1	−1	0	0	0	0	.03*
Difference posttreatment to 3 months' follow-up	0	0	0	0	0	0	.46

md = median; q1 = quartile 1; q3 = quartile 3.
* Statistically significant ($p < .001$).

Table 5. Description and Comparison of Pre- and Posttreatment Visual Analog Scale Scores in Treatment and Control Groups

Visual Analog Scale	Treatment Group (n = 13)					Control Group (n = 11)					Significance Level (*p* value)
	m	SD	q1	md	Q3	m	SD	q1	md	q3	
Difference pretreatment to posttreatment	−12.3	17.4	20	−15	−1	6.8	6.6	2	6	11	.001*
Difference pretreatment to 3 months' follow-up	−15.5	15.7	25	−15	−1.5	5.6	25.7	−10	6	12	.006*
Difference posttreatment to 3 months' follow-up	−3.2	6.2	−5.5	0	0	−1.3	25.4	−14	0	6	.57

m = mean; md = median; q1 = quartile 1; q3 = quartile 3; SD = standard deviation.
* Statistically significant ($p < .001$).

neck, four experienced unchanged tinnitus, two slept better, nine experienced decreased tinnitus, three experienced the treatment as stressful, and two had difficulties in stretching. Eight experienced better awareness of their own body, and all 13 patients experienced the treatment as positive.

DISCUSSION

The somatosensory system can play a role in generating tinnitus. This means that a subgroup of patients might experience tinnitus benefits from proper activation of the somatosensory system [3]. The SPA method is a treatment model based on activation of the somatosensory system by restoring muscle symmetry and muscle balance in the jaw and neck. The treatment aims at teaching patients certain muscle-stretching techniques so that they are able to do the exercises actively on their own and, in doing so, to maintain the effects of the treatment in the long run.

During this study, we adapted the SPA method for performance in a group. The group treatment was demanding for the individual patient in terms of muscle stretching. The patients had to learn how to find the right muscle, use the proper amount of strength, and avoid tightening other parts of the body during the stretch. These circumstances might have influenced the result, as many patients were concerned that they did not stretch the way they were supposed to.

Despite significant reduction of the tinnitus problem according to the Klockhoff and VAS methods (and as assessed at 3-month follow-up), we were not able to determine the correlation between, for example, VAS-Klockhoff and mobility of the neck and posture. This was partly owing to the fact that the patient groups were not homogeneous, differing markedly in terms of neck status, age, disease severity, and other characteristics. In addition, the groups were small. A relation between the degree of tinnitus and the mobility of the neck and posture can be observed on an individual level, but larger studies are needed to elucidate this.

This study had a low number of participants in both groups. It was controlled and blinded but not randomized, which also was a weakness. Also, both the treatment and control groups were chosen consecutively. This implies that the internal validity is strong, whereas the external validity may be weak as compared with, say, a population survey.

The improved result of the neck's mobility remained 3 months after treatment. These improvements could mean that there was a connection between muscle symmetry and reduced tension in the jaw and neck (rotation and lateral flexion) and the degree of tinnitus. However, we were not able to prove that statistically. A larger group of patients or an individual treatment study would be needed to illustrate this further.

The improvements of posture in light of the short period of treatment demonstrated that it was possible to influence posture in such a period by increasing the awareness of one's own body. It was easier to correct the lordosis than the kyphosis. Postural improvement remained 3 months after treatment.

Results from the HADS showed a 69% decrease in the scores of those in the treatment group, whereas the corresponding value in those in the control group was 27%. The decrease in the degree of HADS could be explained by such psychosocial factors as the positive effect of the examination (to be taken into care) and perhaps expectations of an effective treatment (the placebo effect) [17].

The significant result according to the Klockhoff test in those in the treatment group demonstrated the effect of this treatment. As the Klockhoff test is a rough three-degree self-evaluation, it is difficult to change the outcome of the test if the physical changes are not significant. We are aware that the Klockhoff test is not sufficiently sensitive to the measurement of tinnitus, but we chose it because it is used by the Audiological Institution in Lund.

Ten of 13 patients in the treatment group (77%) experienced a decrease in their tinnitus annoyance according to the VAS. One explanation for the high value with the VAS as compared to the Klockhoff test may be that the VAS is a more sensitive scale (0–100). The degree of tinnitus annoyance can more easily be captured on a 100-degree scale than on a 3-degree scale.

Acupuncture is a common complementary physiotherapy treatment used to reinforce treatment by relaxation and to release endorphins to reduce pain [18]. Both the positive effects and absence of effects of acupuncture on tinnitus have been documented in several studies [19], but we have not found any scientific study that evaluates auricular acupuncture as a treatment of tinnitus. The reasons for selecting certain locations for placement of acupuncture needles could therefore be seen as a nonscientific but tested hypothesis. It appeared that some of the patients could—through home training—block off or reduce their tinnitus.

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