Effect of adding a supervised physical therapy exercise program to photobiomodulation therapy in the treatment of cervicogenic somatosensory tinnitus

A randomized controlled study

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Abstract

Objectives: To evaluate the effectiveness of adding a supervised physical therapy exercise program to photobiomodulation therapy (PBMT) in the treatment of cervicogenic somatosensory tinnitus (CST).

Methods: Forty patients suffering from CST with age 45–55 years were included in the study. They were assigned randomly into 2 groups, 20 per each. (Study group) Group (A) received a supervised physical therapy exercise program in addition to 20 minutes PBMT with a 650-nanometer wavelength and a 5 milliWatt power output, spot size of 1 cm\textsuperscript{2}, and energy density of 6 Joules, 3 sessions per week for 8 consecutive weeks, plus traditional medical treatment. While (control group), group (B) received the same PBMT protocol, 3 sessions per week for 8 consecutive weeks in addition to the traditional medical treatment. Tinnitus visual analog scaling (VAS), tinnitus handicap inventory (THI), and cervical range of motion (ROM) were measured at baseline and after 8 weeks.

Results: Mixed MANOVA showed a statistically significant reduction in tinnitus VAS, THI, and a significant improvement in cervical ROM (flexion, extension, right bending, left bending, right rotation, and left rotation) in favor of Group A (\(P < .05\)). There was a significant decrease in posttreatment VAS treatment (\(P > .001\)) MD\( [-2.05(-2.68: -1.41)]\), and THI relative to pretreatment mean difference \([-5.35(-8.51: -2.19)]\) and a significant increase in posttreatment neck ROM in Groups A and B relative to pretreatment neck ROM (\(P > .001\)). Flexion range posttreatment MD\( [3.65(1.64:5.65)]\), Extension MD \( [6.55(1.35:11.75)]\), right bending MD\( [3.8(2.51:5.08)]\), left bending MD\( [1.75(0.19:3.3)]\), right rotation MD \( [3.5(1.28:5.71)]\) and left rotation \( [2.75(0.67:4.82)]\).

Conclusions: Adding a supervised physical therapy exercise program to PBMT showed positive and beneficial effects in the treatment of CST using VAS, THI, and Cervical ROM assessment tools.

Abbreviations: ATP = adenosine triphosphate, CST = cervicogenic somatosensory tinnitus, ENT = ear, nose, and throat, MANOVA = multivariate analysis of variance, MD = mean difference, MTPs = myofascial trigger points, PBMT = photobiomodulation therapy, ROM = range of motion, THI = tinnitus handicap inventory, VAS = visual analog scaling.

Keywords: cervicogenic somatosensory tinnitus, physical therapy exercise program, photobiomodulation therapy

1. Introduction

Tinnitus can be identified as a sound pseudo sensation with nonexistence of sound stimulus. It represents approximately 10%–15% of the adult population; usually, it is known as ringing, sizzling, or hissing, that could be intermittent or persistent, existing in 1 or both ears, or inside the head centrally, it may be associated with multiple causes such as hearing loss and noise trauma.\textsuperscript{[1]}

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The authors declare that the data supporting the study findings are included within the manuscript. All data that support the study findings are available from the corresponding author upon request.

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Somatosensory tinnitus is a commonly recognized subcategory of tinnitus associated with somatosensory, somatomotor, or visual-motor system stimulation. A basic feature of somatosensory tinnitus is defined primarily by its physical contact or motion modulation.\[2\]

Tinnitus perception can extend beyond the sensation of the phantom sound, it affects daily functioning, causing insomnia, involves hearing, and concentration issues, decreasing quality of life and arrogant psychological well-being,\[3\] complications like depression, irritability, sleep disturbances, and lack of concentration may occur.\[4\]

Some cases of tinnitus, head and neck pain, muscle problems, and a decline in cervical range of motion are often reported.\[5\]

Due to the lack of controlled clinical trials of intervention modality, many therapeutic approaches have been suggested, including medical treatment such as antiepileptic drugs, sedatives, antidepressants, local anesthetics, botulinum toxins, and antihistamines.\[6\] In only a small number of trials, physical therapy was considered an intervention for CST.\[7\]-\[10\]

The results of repeated training exercises of head and neck muscle were firstly studied by Sanchez et al in 2007, researchers reported its vital effect on modulation, but not on tinnitus everyday patterns.\[11\]

In patients with CST, manual therapy focuses on musculoskeletal impairments (limited ROM, and pain), muscle function impairments (trigger points, and tone), skin-fold tenderness, and dyskinesthetic position sense in the head and neck.\[7,8\] In addition, the tinnitus loudness and pitch can be controlled by movement of the head, neck, jaw, and shoulder manipulations.\[5\]

Photobiomodulation therapy (PBMT) in outpatients suffering from tinnitus has recently been tested.\[12\] Trans-metatal PBMT was applied through the external ear, using either (630 nm) or (830 nm) wavelength. It was found to be effective for chronic tinnitus treatment. PBMT is believed to increase cell proliferation, adenosine triphosphate (ATP) synthesis, promote inner ear local vascularity, and enable repair mechanisms.\[13\] (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3085173/- R49). Other clinical trials showed no major effectiveness of PBMT in tinnitus treatment.\[14\] (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3085173/- R49).

Regarding physiotherapy techniques, few scientific evidence are available, but some studies have shown that cervical spine mobilization and sub-occipital muscle stretching can decrease tinnitus intensity and improve tinnitus loudness.\[7,10\] To the best of our knowledge, there are no previous studies that evaluated the effect of adding exercise therapy programs to PBMT on the treatment of CST. Therefore, the purpose of the current study was to assess the effect of adding a supervised physical therapy exercise program to PBMT in the treatment of CST.

2. Materials and Methods

2.1. Study design and ethics

This study was a randomized, double-blinded clinical trial (patients and assessor). Subjects were enrolled from (Cairo University Hospitals) and the study was conducted at the Physical Therapy Outpatient Clinic, Faculty of Physical Therapy, Cairo University, between December 2018 and April 2019. Participants were fully informed in detail about the aim and benefits of the study, and before enrollment, they signed written informed consent. Faculty of Physical Therapy Ethical Committee approved the study P.T.REC/012/002633 and the Clinical Trials Registry No. is NCT0464115.

2.2. Participants

Forty patients with cervicogenic somatosensory tinnitus for at least 6 months have been recruited from the ear, nose, and throat (ENT) clinics at Cairo University Hospitals. The inclusion criteria include: Age from 45 to 55 years, unilateral (CST) that is stable for the previous 3 months, the criteria for CST were cervical pain, limited ROM especially rotation, increased symptoms with inadequate resting postures, working, walking, or sleeping, and modulation of these symptoms by motion of head or cervical region, or posture changes), also the presence of trigger points at the craniocervical musculature, occipital muscles tenderness and headache.\[11\] Participants were excluded from the study if they were suffering from tinnitus for free ontological reasons such as external otitis media, tympanic membrane perforation, or conductively loss of hearing, tumors, traumatic cervical spine injury, tumors, neurological issues that may cause tinnitus; failure to interpret, comprehend, fill questionnaires or follow instructions (e.g. blindness, dementia or illiteracy). Recent fracture, tumor, osteoporosis, rheumatoid arthritis, an extended history of steroids) were excluded. The experienced ENT professional conducted a thorough medical evaluation for all participants, including an ENT examination. Any psychotic conditions of hearing hallucination, auditory trauma, mumps, head injury, meningitis.

2.3. Randomization

Fifty-two patients were screened for eligibility requirements, 40 met eligibility criteria and randomly allocated with computer-generated block randomization equally to (Group A) that received a supervised physical therapy exercise program plus PBMT or (Group B) that received only PBMT. To avoid bias selection and decrease inconsistency among the 2 groups, the block size was 4. Concealed allocation was achieved through closed, sequentially numbered opaque envelopes. Medical reports were checked by 1 administration officer and all patients who met the study’s inclusion criteria and who had no exclusion criteria were identified (Fig. 1). Using sealed envelopes, the randomization was performed by 1 researcher who was not included in the data collection or treatment procedures to avoid bias, and 1 researcher has opened the envelopes and proceeded to the treatment. Two researchers who were blinded to which group assignment, conducted the interventional physical therapy modality selected in the study. Another researcher who also was blinded to group assignment has conducted the pre- and postinterventional data collection.

2.4. Outcome measures

Visual analog scale (VAS) was the primary outcome measure, and the Tinnitus Handicap Inventory (THI) and cervical range of motion (CROM) were the secondary outcome measures.

2.5. Visual analog scale

A visual analog scale (VAS) is a rating scale in which the subject rates his condition by putting a corresponding label along a printed line. For the measurement of tinnitus intensity, VAS was used (tinnitus annoyance and tinnitus loudness).\[15\] VAS offers numerical estimates of tinnitus severity: the graduated scale was asked to be followed by patients. Participants were informed to rate the tinnitus loudness from 0 to 10. The highest score suggests the greatest impairment.\[16\]

2.6. Tinnitus handicap inventory

The 25-item tinnitus handicap inventory (THI) questionnaire includes 3 domains: 11-item functional, 5-item disastrous, and 9-item emotional to determine the effect of tinnitus on everyday activities. Each item has 3 possible answers: “yes” (score 4), “sometimes” (score 2), and “no” (score 0). While it is possible to score each subscale individually, it was suggested to report a
total score (range 0–100 points). The score of 0–16 indicated grade 1 (slight; hearing of tinnitus in a quiet environment only), 18–36 indicated grade 2 (mild; easy to mask tinnitus by ambient sounds and easy to forget about it with activities), 38–56 indicated grade 3 (moderate; notice of tinnitus in the occurrence of noise background while activity daily living could still be conducted), 58–76 indicated grade 4 (severe; approximately continuously heard, resulting in disturbed sleepiness and activity daily living), 78–100 indicated grade 5 (catastrophic; always heard, resulting in disturbance in patterns of sleep and difficulties in all activities). It was suggested that a 20-point reduction or more in the total score of THI may be considered a clinically relevant improvement.

2.7. Measurement of cervical range of motion

The ROM device (Performance Attainment Associates, St. Paul, MN, USA) was used with the standard technique for flexion/extension, lateral flexion, and rotation. The therapist is standing next to the trunk of the patient, starting with the sitting position of the patient. The calculation started from the head-resting place, the measurements have been taken 3 times, and the mean measurement was obtained. All measurements were conducted at the baseline and 8 weeks after intervention.

2.8. Intervention

All patients in both groups (A and B) received PBMT, for 20 minutes per session, 3 times weekly for 8 consecutive weeks. A diode laser with 650 nm wavelength and 5 mW output power (Tinnitus, Switzerland). Laser energy transferred to the external auditory meatus through the PPMT probe. The beam was emitted into the tympanic membrane with a divergent lens of 17°, producing a spot size of 1 cm² and 6 J energy density at the tympanic membrane during a session that lasts for 20-minute irradiation. In addition to medical treatment for 8 weeks in the form of melatonin (3 mg daily, 1–2 hours prior to sleep). Participants in the study group (A) conducted an additional supervised physical therapy exercise program for the cervical area, 3 sessions per week for 8 weeks, including myofascial trigger point release, stretching exercise, and posture exercises, for a total of 30 minutes per session.

2.9. Myofascial Trigger point release

Tenderness of myofascial trigger points (MTPs) was measured using manual pressure. An active trigger point can be identified when a hyperirritable spot is placed in a detectable tight band through the muscle, with referred pain caused by pressing this location. A steady and ongoing digital pressure on the MTP until the patient no longer feels any sensory abnormalities, referred pain, or discomfort at the place where such pressure is administered this is called pressure release. The following muscles were subjected to longitudinal strokes: Masseter, temporalis, sternocleidomastoid, and upper trapezium. These muscles were chosen because of their relation to tinnitus-causing pain in the temporomandibular joint, ear, and orofacial area.

The pressure was performed with a 10-second deep continuous pressure using a single finger by a distal phalanx of the index finger as a spade-like pad or by pincer grasp (thumb and finger palpation) going in the hypersensitive region through the muscle band, with the patient in a quiet environment to promote comprehensive potential tinnitus modulation.

2.10. Stretching exercises

In an attempt to relax before stretching exercises, the patient was told to lower his shoulders, breathe deeply with the diaphragm, turn his head and neck in the direction of the vertical
line, and raise his chest. Pull the jaw and feel the stretch, just below the base of the skull. Slowly raise the head towards the ceiling. Passive static stretching exercise has been done for sternocleidomastoid, scalene, levator scapulae, rhomboids, posterior neck musculature, upper, and middle trapezius muscles for 30-second stretching exercise, with the maintenance of 20 seconds, repeated 3 times with the patient feeling of mild discomfort due to stretch. At the end of the stretch, gently turn the head left and right at atlantoaxial joint to decrease tension in the neck muscles.[31] Based on the proprioceptive neuromuscular facilitation, temporalis, masseter, jaw, lateral, and medial pterygoid muscles were consequently stretched.[30]

2.11. Postural exercises
Dynamic and static posture, movement preference, and somatosensory mechanical stimulation of upper extremity and cervical spine joints were done very gently and repeatedly, at low speed.[9] The modified postural exercise was performed according to the recommendations suggested by Kennell & McCreary, 1993: posterior deltoid, supraspinatus, upper trapezius, levator scapulae, and masseter muscles were exercised with the patient in a sitting position. The posterior deltoid was stretched with the shoulder in medial rotation, extension, and slight abduction; the patient was instructed to perform a static extension contraction. Supraspinatus muscle was stretched with 10° abduction and neutral rotation; the patient was instructed to perform a static abduction.[31] The upper trapezius was stretched with 90° arm abduction and neutral rotation; the patient was instructed to perform a static shoulder abduction. Levator scapulae was stretched with same side neck lateral rotation, the patient was instructed to perform a static shoulder elevation. Masseter muscles were stretched through asking the patient to statically perform a biting down as hard as possible on cleaned mouth guards.[31]

From a prone position, the patient was instructed to perform a postural exercise for rhomboid major, in the form of a static shoulder retraction as well as cervical erector spinae, in the form of static neck extension contraction. Finally, from supine position, the patient was instructed to flex the neck statically with the same side neck lateral flexion and opposite-side rotation, for sternocleidomastoid. Throughout the study, a strategy was used to protect against patients' un-blindness, patients in each group were assessed and treated at different times, and no communication, therefore, occurred between patients. The treatment of blindness has continued up to the study program termination.[31]

2.12. Sample size estimation
Before the study, sample size measurements have been carried out using G*POWER statistical software (version 3.1.9.2; Franz Faul, Universität Kiel, Germany) based on the previous study,[32] using VAS as the primary outcome that estimated that the appropriate sample size for this study to be 17 in each group. The number increased to 20 for possible dropouts. The estimation of the sample size was performed in line with an allocation ratio of N2/N1=1, α of 0.05, β of 0.2, and effect size of 0.99.

2.13. Statistical analysis
For comparison of subject characteristics between both groups, descriptive statistics and unpaired t-tests were performed. For comparison of sex and affected sides distribution between groups, the Chi-squared test was used. Using the Shapiro–Wilk test, normal data distribution was tested. To ensure homogeneity between groups, the Levene variance homogeneity test was conducted. A mixed design multivariate analysis of variance (MANOVA) was performed to compare inter and intragroup effects on VAS, THI, and neck ROM. Post-hoc tests using the Bonferroni correction were performed for successive multiple comparisons. The significance level was considered at $P < .05$ for all statistical tests. All statistical analysis was performed using the Windows version 25 Statistical Package for Social Studies (IBM SPSS, IBM Corp., Armonk, NY, USA).

3. Results
3.1. Subject characteristics
Table 1 shows the mean ± SD of the subjects’ ages in Group A and B. No significant differences were detected between groups in the mean age ($P < .05$). Also, no significant differences were detected in the distribution of sex and affected sides between both groups ($P > .05$).

3.2. Effect of treatment on VAS, THI, and neck ROM
Mixed MANOVA revealed a significant time and group interactions (Wilks’ Lambda = 0.43; $F = 4.97, P = .001$). The main effect of time was significant (Wilks’ Lambda = 0.05; $F = 61.54, P = .001$). There was a significant main effect of group (Wilks’ Lambda = 0.44; $F = 4.86, P = .001$). Table 2 exhibits descriptive analyses of VAS, THI, and neck ROM and a comparable level of significance between the groups and a comparable level of significance between each group pre- and posttreatment.

3.3. Within group comparison
In groups A and B, a significant decrease was detected posttreatment in VAS and THI when compared with pretreatment treatment ($P > .001$). A significant increase was detected posttreatment in neck ROM in Groups A and B relative to pretreatment neck ROM ($P > .001$) as summarized in Table 2.

3.4. Between group comparison
No significant differences were detected in all parameters between groups pretreatment ($P > .05$). Comparison between A and B groups posttreatment revealed significant decreases in VAS and THI of Group A compared with that of Group B ($P < .05$). Also, there was a significant increase in flexion, extension, side bending, and rotation of the Group A compared with that of the Group B ($P < .05$) as detailed in Table 3.

Table 1
Basic characteristics of participants.

| Sex      | Group A | P value |
|----------|---------|---------|
| Male     | 13 (65%)| 10 (50%)| .33     |
| Female   | 7 (35%) | 10 (50%)| .42     |
| Affected sides | Group A | Group B |
| Bilateral| 15 (75%)| 17 (85%)|         |
| Unilateral| 5 (25%) | 3 (15%) |         |

x = mean, $P$ value = probability value, SD = standard deviation.

4. Discussion
The results of this study showed a significant decrease in Group (A) VAS and THI relative to Group (B) ($P > .05$). In addition, there was a significant increase in Group A flexion, extension,
side bending and rotation of Cervical ROM relative to Group B ($P > .05$). The effect of exercises on improving tinnitus severity may be attributed to an improvement in the neurotrophic factor extracted from the brain. [33]

The underlying mechanism that interprets tinnitus improvement after the application of manual therapy might be a result of training with repetitive movements that induce neural plasticity through certain neurophysiological changes. It has been shown that neural plasticity triggering has beneficial effects on various conditions, such as vestibular diseases, where the repetition of complex techniques can reduce these symptoms. Muscle contractions have been shown to alter the trend of temporary worsening of tinnitus to temporary improvement, by the repetition of tinnitus-modulating exercises, [11] it can be interpreted by the convergent physiological and anatomical connection between the dorsal cochlear nucleus and somatosensory systems. [10,34]

In patients with CST, manual therapy focused mainly on musculoskeletal disorders, forward head nodding, static posture and restricted mobility of cervical joints and spine, impaired muscle tone, function, endurance, painful upper cervical joints, trigger points, tenderness, and sense of dyskinesthetic neck and head position. [33]

The findings of the current study are concurrent with previous studies, [14–40] that referred tinnitus modulation following manual exercise therapy to the following factors: palpation of the sternocleidomastoid muscles, masseter, pterygoid, or myofascial trigger points, sub-occipital muscle stretching exercises, along with rotatory movement and relaxation exercise of the atlantooccipital joint. [27,29] Comparing self-training stretching, posture correction, and acupuncture targeting balance and muscle symmetry in the cervical and jaw region, the previous studies documented immediate and/or long-term (3 months) improvement of CST. [7] in addition to case reports that prove a reduction

### Table 2
Mean VAS and THI pre- and posttreatment of the Group A and B.

|                      | Group A ±SD     | Group B ±SD     | MD (95% CI)     | $P$ value |
|----------------------|-----------------|-----------------|-----------------|-----------|
| VAS                  |                 |                 |                 |           |
| Pretreatment         | 7.44 ± 0.69     | 7.25 ± 0.71     | 0.19 (−0.25; 0.64) | .38       |
| Posttreatment        | 3.6 ± 0.82      | 5.65 ± 1.13     | −2.05 (−2.88; −1.14) | .001      |
| $P$ value            | .001            | .001            |                 |           |
| THI                  |                 |                 |                 |           |
| Pretreatment         | 46.3 ± 7.61     | 45.9 ± 8.23     | 0.4 (−4.67; 5.47) | .87       |
| Posttreatment        | 31.05 ± 4.43    | 36.4 ± 5.4      | −5.35 (−8.51; −2.19) | .001      |
| $P$ value            | .001            | .001            |                 |           |

$x =$ mean; $CI =$ confidence interval, $MD =$ mean difference, $P$ value = level of significance, $SD =$ standard deviation.

### Table 3
Mean neck ROM pre- and posttreatment of the Group A and B.

| ROM (degrees)     | Group A ±SD     | Group B ±SD     | MD (95% CI)     | $P$ value |
|-------------------|-----------------|-----------------|-----------------|-----------|
| Flexion           |                 |                 |                 |           |
| Pretreatment      | 40.1 ± 5.3      | 39.75 ± 4.17    | 0.35 (−2.7; 3.4) | .81       |
| Posttreatment     | 50 ± 2.1        | 46.35 ± 3.89    | 3.65 (1.46; 5.65) | .001      |
| $P$ value         | .001            | .001            |                 |           |
| Extension         |                 |                 |                 |           |
| Pretreatment      | 53.85 ± 14      | 54.8 ± 9.83     | −0.95 (−8.69; 6.79) | .8        |
| Posttreatment     | 74.75 ± 6.38    | 68.2 ± 9.55     | 6.55 (1.35; 11.75) | .001      |
| $P$ value         | .001            | .001            |                 |           |
| Right bending     |                 |                 |                 |           |
| Pretreatment      | 36.95 ± 4.12    | 35.8 ± 3.63     | 1.15 (1.33; 3.63) | .35       |
| Posttreatment     | 44.55 ± 1.27    | 40.75 ± 2.53    | 3.8 (2.51; 5.08) | .001      |
| $P$ value         | .001            | .001            |                 |           |
| Left bending      |                 |                 |                 |           |
| Pretreatment      | 36.2 ± 4.55     | 36.25 ± 3.64    | −0.05 (−2.68; 2.58) | .97       |
| Posttreatment     | 43.65 ± 2.2     | 41.9 ± 2.63     | 1.75 (0.19; 3.3) | .02       |
| $P$ value         | .001            | .001            |                 |           |
| Right rotation    |                 |                 |                 |           |
| Pretreatment      | 62.1 ± 8.38     | 60.6 ± 9.08     | 1.5 (−4.09; 7.09) | .59       |
| Posttreatment     | 70 ± 1.62       | 68.5 ± 4.61     | 3.5 (1.28; 5.71) | .003      |
| $P$ value         | .001            | .001            |                 |           |
| Left rotation     |                 |                 |                 |           |
| Pretreatment      | 62.7 ± 7.06     | 60.8 ± 6.23     | 1.9 (−2.36; 6.16) | .37       |
| Posttreatment     | 70.25 ± 2.55    | 67.5 ± 3.8      | 2.75 (0.67; 4.82) | .01       |
| $P$ value         | .001            | .001            |                 |           |

$x =$ mean; $CI =$ confidence interval, $MD =$ mean difference, $P$ value = level of significance, $SD =$ standard deviation.
of CST severity after mobilization of the cervical spine and suboccipital muscle stretching,[10,33] a collaborative approach to tinnitus-related sensitization and subjective tinnitus was also recommended, focusing on patient-based tinnitus education and physical therapy.[3]

Stretching and massage have helped some tinnitus patients.[36] It was documented that 1 female case reported a decrease in tinnitus symptoms, dizziness, and chronic cervical and facial pain, after having MTPs disengaged by releasing pressure along with home-based exercise (hot packs, stretching exercise, combined with postural guiding).[14] There is interrelation to pain syndromes where the tinnitus is an accompanying symptom of myofascial pain and tension, the current study results in some modulation of the tinnitus experience in an attempt to detect those MTP in tinnitus patients seems to be relieved, especially when patients report about trigger points and influence on the tinnitus.

Digital MTPs compression at the region of the shoulder girdle, head, and neck muscles proved to reduce the tinnitus in 55.9% of patients who suffered from CST in a study conducted by Rocha[37] the authors concluded that both type and intensity of the sound were influenced. Decreasing the symptoms of tinnitus after MTP release may be referred to as the deactivation of MTPs that decreases tinnitus or even causes it to disappear in certain individuals, suggesting a correlation between some types of tinnitus and MTPs.[38,39] Tinnitus modulation was evoked by cervical muscle contraction training, after 2 months of intervention.[40]

A physiological explanation for the effect of neck treatment on tinnitus is the connection between the somatosensory system of the cervical spine with the central auditory system and more specifically with dorsal cochlear nuclei by afferent fibers. This makes the somatosensory system able to influence the auditory system by altering the spontaneous rates or synchrony of firing of neurons and leads to changes in the intensity and the character of the tinnitus.[41]

A clinical trial by Deglado et al, to investigate the effect of cervico-mandibular manual therapy plus exercise and educational program resulted in better outcomes than the application of exercise/education alone in individuals with tinnitus attributed to TMD.[28]

A systematic review and meta-analysis of randomized controlled trials concluded that manual therapy has proven to be effective in improving quality of life as well as pain pressure threshold in somatic tinnitus patients.[42]

Cote et al conducted a study to explore the effect of a physiotherapy program on the intensity and severity of somatosensory tinnitus, their results revealed significant improvement in tinnitus severity in individuals presenting with somatosensory components received an average of 10 physiotherapy treatments over 6 weeks. Treatments included cervical and thoracic mobilizations, as well as muscular strengthening, stretching, postural instruction, and cervical stabilization.[43]

Manual therapy appears to be an effective intervention for individuals with somatic tinnitus, especially if they have co-occurring tinnitus or tinnitus sensitization. In addition, a multimodal intervention approach may be the ideal way in which to positively impact an individual’s activities of daily living.[44]

Regarding the effect of PBMT on the improvement of tinnitus manifestations, it is assumed that PBMT is beneficial in promoting cell proliferation, improving ATP and collagen synthesis, stimulating growth factor release, enhancing inner ear local circulation, and activating the mechanism of healing in ear cells via mitochondrial stimulation.[45] The current study comes in parallel with prior studies that described a significant decrease in VAS and THI after 20 sessions of PBMT.[46,47] In addition, a marked decline was documented in VAS in chronic tinnitus patients after 1 month of application of PBMT.[46] The positive effect of the PBMT application, every day for 1 week, on enhancing the degree of tinnitus loudness, duration, and annoyance by 48.8%, 57.7%, and 55.5%, respectively, was examined instead of its thermal effect; the ameliorative effect of PBMT on chronic tinnitus may be related to its biological effect.[43] On contrary, the current study disagreed with the results of other studies using PBMT, but no significant difference was observed after the application of PBMT.[48–50] Controversy might be referred to the difference in the duration of the treatment and the design, as well as to the variance in the procedure, parameters, and location of the application of PBMT.

According to the results obtained from the current study, adding an exercise therapy program to PBMT can be more beneficial than each of them alone. According to the novelty of the literature, no previous study was conducted to evaluate the effect of adding a program of physical therapy exercise to the PBMT on CST.

The study was limited to the lack of a long-term follow-up period, so further studies are required to evaluate the long-term follow-up. The number of the MTP should be used as a method of assessment in future research, also a comparison between males and females to investigate the effect of treatment as correlated to gender in different age categories.

5. Conclusion

Adding a supervised physical therapy rehabilitation program to PBMT for 8 weeks is a useful modality in the treatment of chronic CST. The combination of physical therapy rehabilitation and PBMT should be recommended in the rehabilitation protocols for the treatment of chronic CST.

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