The effect of vibration therapy on the phonatory function of the larynx and thyroid function in female voice professionals

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Abstract

Background: Poor posture, increased muscle tension, gastroesophageal reflux, thyroid problems, hormonal changes, and prolonged stress can all negatively affect voice performance. Among chronic conditions that impact voice quality, thyroid disease is the most commonly cited.

Aims: The aim of this study was to evaluate the effects of vibration therapy on both voice production and thyroid function in female professionals who use their voices extensively.

Material and methods: This study included 48 women diagnosed with functional dysphonia, randomly divided into a study group (n=34) and a control group (n=14). The intervention consisted of three 30-minute sessions per week over a six-week period using the Vitberg Rehabilitation Massager. Assessments included thyroid hormone levels (TSH, fT3, fT4) and Mean Phonation Time (MPT) before and after therapy.

Results: Statistically significant differences were found in the study group for fT3 (pg/ml*) and TSH (uIU/ml*) levels after therapy, with mean fT3 levels decreasing from 3.18 (SD±0.36) to 2.96 (SD±0.33) and mean TSH levels showing no significant change. In contrast, the control group showed no significant differences in TSH levels but did exhibit significant changes in fT3 levels. Additionally, the study group demonstrated a significant increase in MPT from 13.17 seconds (SD±2.25) to 15.97 seconds (SD±2.87), while the control group showed a decrease in MPT.

Conclusions: Vibration therapy significantly affected hormone levels (TSH and fT3) and improved MPT in the study group compared to the control group. These findings suggest that vibration therapy may be a beneficial intervention for improving voice quality and thyroid function in female voice professionals.

Key words

voice therapy, vibration, voice professionals, thyroid function, dysphonia.

Introduction

Research reports that the voice contains a great deal of information such as age, gender [1], body type [2], physical strength [3] and social status [4]. Data from the Central Register of Occupational Diseases show that voice disorders are the third most common occupational disease in Poland [3, 4]. Voice function can be negatively influenced by various factors, including poor posture, increased muscle tension, gastroesophageal reflux, thyroid disease, hormonal fluctuations and chronic stress [5].

The widely recognised natural ageing process is typically associated with the onset of an increasing number of chronic diseases. Some of these conditions may directly or indirectly affect voice quality, possibly as a side effect of medication. Among the chronic diseases known to affect voice quality, thyroid disease is the most commonly reported. In Poland, thyroid disease affects about 22% of the population. In 60% of patients, the first symptoms are related to changes in voice quality and performance [6].

Vibration therapy is a form of physiotherapy that uses oscillatory - cycloidal - vibratory stimuli. Vibration amplitudes between 0.01 and 2.00 mm have been found (by Hummel et al.) to produce the most effective treatment results. The effectiveness of vibration therapy has been confirmed by numerous scientific studies. Most patients achieved the best results when moderate pressure and a device with a large treatment area cushion were used. The vibrations generated by the RAM Vitberg+ are non-invasive and mechanical, with input parameters selected according to the indication. The body responds differently depending on the specific vibration therapy programme used and how the stimulus is applied. The frequency used by the RAM Vitberg+ is considered to be the most effective in normalising muscle tone [7].

To our knowledge, there are no available studies evaluating the effect of oscillatory-cycloidal vibrotherapy on thyroid-stimulating hormone secretion, which prompted us to conduct research in this area. There are reports on the vibration stimulus used in the form of training on a vibration platform (whole body vibration, WBV). However, there are inconsistencies in the literature regarding the effects of vibration therapy on the body's hormonal response. As mentioned by Moreira-Marconi (2020), this is due to several confounding factors, such as: lack of consistent control conditions, heterogeneous study groups and different experimental conditions (frequency, work time, rest time, number of sessions, type of vibration platform or vibration) [8].

Aims

The aim of the study was to evaluate the effect of vibration therapy on both voice production and thyroid function (TSH [uIU/ml*], fT4, [ng/dl*], fT3 [pg/ml*]) in female professionals who use their voices extensively.

Material and methods

Ethical considerations

The study was designed and conducted in accordance with the Declaration of Helsinki (1964) and was approved by the Bioethics Committee of the Andrzej Frycz Modrzewski University of Science and Technology in Krakow (Poland), with reference number KBKA/72/O/2021. Subjects were informed about the purpose and design of the study, the methods used, and the possibility to withdraw at any time. The study procedure was non-invasive.

Study participants

The research took place in the Vibration Therapy Laboratory of the University of Physical Education in Krakow, from September 2021 to November 2022. The study participants were actively engaged women (outgroup homogeneity) from various professional backgrounds, including actresses, singers and teachers. A total of 48 Caucasian females with diagnosed functional dys-

phonia, aged between 30 and 50 years (mean age=34.4; SD±5.93), were included in the study material. The participants were randomly divided into two groups: the study group (N=34, mean age=36.2; SD±4.36) and the control group (N=14, mean age=30.2; SD±2.44).

Measurements

Eligible subjects underwent a specialist phoniatric assessment (using fibreoscopy) to determine whether they had any voice abnormalities as evidenced by vocal nodules, dysphonia or hoarseness (subjective and objective voice examination). In addition, aerodynamic voice tests - Mean Phonation Time (MPT [s]) and measurements of hormone levels (TSH, fT3 [pg/ml*], fT4[ng/dl*]) were performed prior to the scheduled vibration therapy sessions. It was essential that the subjects had normal articulation, no orthopaedic, neurological or hormonal disorders and good intellectual functioning.

Intervention

The therapeutic process included several sessions in the vibration therapy laboratory using the Vitberg Rehabilitation Massager with the 'Neck' module (Vitberg Jacek Sikora-Nowy Sącz) (**Figure 1**). The applied vibration stimulus had a frequency of 10.10 Hz to 52.20 Hz, an amplitude of 0.01 mm to 0.21 mm and an acceleration of 0.01 m/s^2 to 13.50 m/s^2. The vibration indicators used varied over time according to the characteristics of the programme. There were three 30-minute treatment sessions, three times a week for six weeks. At the end of the therapy, the study participants were re-evaluated for both thyroid and voice function. The control group received no intervention, only two tests of selected hormones and phonation.

Statistical analysis

The results were analyzed using Statistica 12 software (StatSoft, Palo Alto, CA, USA). The normality of the data distribution was assessed using the Shapiro-Wilk test. For normally distributed data, paired t-tests were used to compare pre- and post-treatment values within groups. For non-normally distributed data, the Wilcoxon signed-rank test was applied. Comparisons between the study and control groups were performed using the Mann-Whitney U test. Statistical significance was set at $p<0.05$ for all tests. Descriptive statistics, including means, medians, standard deviations (SD), minimum (Min), maximum (Max) values, and interquartile ranges (Q1, Q3), were calculated for all variables.

Results

A statistically significant difference (p=0.001) was found between the fT3 levels (pg/ml*) measured within the study group. The mean pre-treatment fT3 level (pg/ml*) in the study group was 3.18 (SD±0.36), while the mean post-treatment fT3 level was significantly lower at -2.96 (SD±0.33). A statistically significant difference (p=0.002) was observed for fT4 concentration (pg/ml*) in the study group. In half of the subjects, the fT4 concentration (pg/ml*) in the study group was not higher than 1.18 (median) before treatment and not lower than 1.18 in the other half, compared to the significantly lower median of 1.11 after treatment. Analysis of plasma TSH levels (uIU/ml*) before and after a series of vibration therapy treatments showed no significant differences (p=0.737) in measurements in the control group (**Table 1**). The mean TSH (uIU/ml*) in the control group before therapy was 1.62 (SD±0.72), which was not significantly higher after therapy with a mean of 1.66 (SD±0.77).

In the control group, a statistically significant difference (p=0.016) was found between the measurements of fT3 concentrations (pg/ml*). Half of the subjects had a pre-treatment fT3 concentration (pg/ml*) no higher than 2.93 (Me) and the other half no lower than 2.93, compared to a significantly higher median post-treatment concentration of 3.13.

Figure 1. Vibrotherapy treatment with the 'Neck' module in a semi-recumbent position – view from the front and the right side.

Table 1. Comparative analysis of the TSH parameter for the control group before and after six weeks

Measurement	T-test for dependent samples	M	SD	Difference	SD	t	df	p
Before	TSH (uIU/ml*)	1.62	0.72		Difference			
After	TSH (uIU/ml*)	1.66	0.77	-0.04	0.46	-0.3	13	0.737

Notes: * *Statistically significant relationship (p<0.05).*

Abbreviations: *TSH – thyroid stimulating hormone; M – mean; SD – standard deviation; t – t-test value; df – degrees of freedom; p – level o statistical significance.*

In the control group, there was no statistically significant difference (p=0.103) between the measurements of fT4 concentration (ng/dl*). Of the subjects in the control group, half had a pre-treatment fT4 concentration (ng/dl*) not exceeding 1.12 (median), while the other half did not fall below 1.12. This contrasts with the non-significantly higher median concentration of 1.24 observed after treatment.

At a significance level of 0.05, a statistically significant difference in the change (after vs before therapy) of the measurements between the study and control groups was observed for fT3 (pg/ml*) (p=0.000) and fT4 (ng/dl*) concentrations (p=0.005) (**Table 2**). In half of the subjects in the study group, the change in fT3 concentration measurements (pg/ml*) was no greater than -0.18 (Me) and in the other half no less than -0.18,

compared with the significantly higher median parameter change of 0.08 in the control group. In contrast, the change in fT4 concentration measurements (ng/dl*) was not greater than -0.05 (Me) in half of the subjects in the study group and not less than -0.05 in the other half, compared with the significantly higher median parameter change of 0.10 in the control group.

Analysis of the results for the measurement of mean phonation time (MPT [s]) in the study group showed a statistically significant difference (p=0.000) in MPT between the results obtained before and after therapy. The mean pre-treatment MPT in the study group was 13.17 seconds (SD±2.25), whereas the significantly higher mean post-treatment MPT was 15.97 seconds (SD±2.87) (**Table 3**).

Analysis of the results for the Mean Phonation Time (MPT [s.]) measurement in the control group showed a statistically significant difference (p=0.002) in MPT between the results obtained before and after therapy. The mean Mean Phonation Time (MPT [s.]) in the control group before therapy was 13.14 seconds (SD±1.92), compared to the significantly lower mean of 11.79 seconds (SD±1.48) after therapy. At a significance level of 0.05, a statistically significant difference in the change (after vs. before therapy) of the measurements was observed between the study and control groups for MPT (p=0.000). In the study group, the mean increase in Mean Phonation Time (MPT [s.]) was 2.80 seconds (SD±2.28), while the control group showed a significantly different mean decrease of -1.36 (SD±1.34).

Table 2. Mann-Whitney U test result for fT3 and fT4 between the groups.

Mann-Whitney U test	Rank.sum	Rank.sum	p	N	N
	Study group	Control group		Study group	Control group
fT3 change (pg/ml*)	654.0	522.0	0.000*	34	14
fT4 change (ng/dl*)	710.5	465.5	0.005*	34	14

Notes: ** Statistically significant relationship (p<0.05).*

Abbreviations: *FT4 – free-tetraiodothyronine; p – level o statistical significance; N – number of participants.*

Table 3. Results of the MPT (s.) parameter in the study group before and after therapy.

Descriptive statistics - before therapy	Study group	M	Me	Min	Max	Q1	Q3	SD
MPT [s]	34	13.17	13.55	7.30	18.00	12.00	14.00	2.25
MPT [s]	34	15.97	16.00	10.00	22.00	14.00	19.00	2.87

Abbreviations: *MPT – mean phonation time in seconds after three attempts; M – mean; Me – median; Min – minimum value; Max – maximum value; Q1 – lower quartile; Q3 – upper quartile; SD – standard deviation.*

Discussion

The emergence of new professions that require excellent vocal function has led to an increase in the number of professional groups that need to be covered by specialised treatment and prevention of voice disorders [9]. The study evaluates how vibration therapy treatments affect vocal emission in female vocal professionals, as well as some hormonal factors that determine pituitary and thyroid function. According to our research, patients with dysphonia benefit from the use of oscillatory-cycloidal vibration therapy treatments, which may also improve thyroid function. Other authors [10] stress the positive effects of vibration therapy when used in medicine, for example to relieve chronic pain, to facilitate rehabilitation of musculoskeletal disorders and as an adjunct to exercise.

The relationship between external vibration therapy (EVT) and vocal performance in professional singers was investigated by Anderson et al. [10]. Twenty-seven women were evaluated at the Toronto Vocal Clinic (14 treatment and 13 placebo subjects), focusing primarily on acoustic parameters of the voice and perceived discomfort (vocal discomfort scale). Compared to placebo, the study showed an immediate difference in acoustic parameters in the subjects who received local vibration therapy. The results of the cited authors are in line with our research, which has also shown that vibration can improve vocal performance in professional singers. Undeniable advantages of vibration therapy include its safety, analgesic effect and comfort during therapy sessions. Such therapy could potentially form part of a comprehensive phoniatric treatment or complement a hormonal treatment.

Recent reports by Niebudek-Bogusz et al. [11] suggest that psychological factors may also be responsible for the quality of the voice produced. In particular, the influence of occupational stress on the quality of voice production is highlighted. The working conditions of a teacher include increased stress, but also poor classroom acoustics, exposure to chalk dust and speaking at high volume. Teachers are also exposed to noise. Secondary voice changes can occur even after three to seven years of speaking under such conditions. Changes can be observed in 50% and 90% of those who speak in noise above 85 dB and 90 dB respectively [11]. Aerodynamic phonation tests, the Voice Handicap Index (VHI), Voice Impairment Scale (VIS) and the Acoustic Voice Quality Scale (AVQI) were used by a Belgian researcher in his study [12] using a Novafon topical device for laryngeal vibration therapy. The study, conducted on eleven people with dysphonia, was based on acoustic parameters of their voice, which showed remarkable post-treatment effects ($p \leq 0.01$). Aerodynamic measurements showed small treatment effects after NLVVT and the results obtained were not statistically significant ($p > 0.05$), contrary to the results of our research. Studies have shown that a possible reason for the benefits of using local vibration in voice therapy could be the stimulation of blood circulation, acceleration of metabolism and relaxation (normalisation) of muscle tension.

The importance of physiotherapy in the treatment of patients with dysphonia was demonstrated in a study by Craig et al. [9]. Three groups of participants were formed: the first group received voice therapy alone, the second group received voice therapy in addition to physiotherapy, and the third group received physiotherapy alone. A study of 153 people showed that the median VHI or VIS did not show any significant differences between the second and third groups. This suggests that physiotherapy is of great importance in the treatment of dysphonia. Certainly, more extensive comparative studies are needed to better describe the role of physiotherapy in the treatment of voice disorders. Body tissues are subjected to various forms of mechanical vibration of variable frequency, amplitude and duration. These vibrations can have both positive and negative effects on the human body.

Data from pilot studies by Wagner (2016) [13] and others indicate the possibility of using vibrations from phonation to stimulate thyroid hormone production and expand existing methods of treating some thyroid-related disorders. It is therefore worth considering the use of an additional gentle stimulating stimulus in the form of oscillatory-cycloidal vibration which, according to these studies, may have a beneficial effect on the levels of thyroid-stimulating hormones (TSH and fT3). The analysis of the influence of thyroid hormones on voice quality is becoming increasingly common. Attention is being drawn to the global ageing process, including all structures of the vocal tract – "presbyphonia". The role of thyroid dysfunction in the assessment of voice quality is emphasised. During clinical observation, a change in the tone of the voice is noted – hoarseness, lowering of the voice, fatigue and weakening of the voice [14].

In addition, phoniatric and hormonal tests are needed to diagnose any problems and provide treatment as soon as possible. A major limitation of the trial was the small size of the groups and the lack of a placebo.

Conclusions

The applied vibration therapy significantly affected the hormone levels of TSH (uIU/ml*) and fT3 (pg/ml*) in the study group. It prolonged the mean phonation time (MPT [s]) in the study group compared to the control group.

Declarations

Ethical Considerations: The study was was approved by the Bioethics Committee of the Andrzej Frycz Modrzewski University of Science and Technology in Krakow (Poland) with reference number KBKA/72/O/2021. Participants were informed about the purpose and design of the study, the methods used, and their right to withdraw at any time. All participants provided written informed consent. The study was designed and conducted in accordance with the Declaration of Helsinki (1964) and Good Clinical Practice (GCP) guidelines.

Clinical Trials: This study was not registered as a clinical trial as it did not involve investigational products or interventions that would classify it under clinical trial regulations.

Conflict of Interest: The authors declare no conflict of interest. The study was conducted independently and without any influence from external organizations or entities.

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