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Original Article

Effects of Music in Combination with Vibration in Acupuncture Points on the Treatment of Fibromyalgia

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Abstract

Objective: Fibromyalgia (FM) is a disease that causes widespread pain and increased sensitivity to pain because of a dysfunction in the central nervous system. This study investigated the effect of music combined with vibration on acupuncture points for the treatment of FM.
Methods: A total of 120 patients with FM were allocated randomly to four groups (30 patients each). One group listened to a sequence of Bach's compositions. The second group was subjected to vibratory stimuli on a combination of acupuncture points on the skin. The third group (complete) underwent both procedures in a simultaneous and synchronized manner, with inclusion of binaural beats. The fourth group (control) received no stimulation. The participants underwent the experimental procedure during five sessions performed on alternate days. They were assessed by the Fibromyalgia Impact Questionnaire (FIQ) and the Health Assessment Questionnaire (HAQ) before the first session and after the last session (20 days).
Results: All groups showed a significant improvement in FIQ and HAQ scores at the evaluation after the intervention. The complete group exhibited the best result on both the FIQ and HAQ ($p < 0.001$), and the improvement in HAQ score was significant ($p < 0.004$).
Conclusions: The results suggest that the placebo effect in FM may be substantial. However, comparison between groups revealed that the complete group had the greatest reduction in both FIQ and HAQ, with a significant improvement in HAQ, suggesting that the combined use of music and vibration exerts a greater effect on FM symptoms.

Introduction

Fibromyalgia (FM) causes widespread pain and increased sensitivity of the skin and musculoskeletal system. It is a multifactorial condition that, in addition to pain, also includes other symptoms, such as sleep disorders, stiffness, fatigue, anxiety, and depression. As a rule, the diagnosis is clinical and exclusionary because no confirmatory tests exist. Moreover, because no definitive treatment is available, medication or nonpharmacologic therapies may alleviate the symptoms.[1]

Among the many nonpharmacologic treatments for FM are acupuncture and music. Acupuncture involves the insertion of needles at particular points of the body for therapeutic purposes. Acupuncture is believed to have originated in China, and it is a component of Traditional Chinese Medicine (TCM).[2] In addition, various other cultures have developed different variations of acupuncture. For instance, the Ñandeva Indians (Tupi Guarani) from Brazil stimulated points on the skin using bamboo flutes.[3] Those skin-point locations are the same as the TCM acupuncture points.

The ethnomusicology literature reports that music accomplishes a variety of functions in different civilizations, including entertainment, ritual treatment, and maintenance of social and natural orders.[4]

The musical sound stimuli that exert an emotional influence and the vibration created by such stimuli might be perceived by other structures possessing peripheral receptors (mostly located on the skin), whereas the hair cells of the internal ear derive from epithelial tissue.[5,6] These peripheral receptors might be stimulated by sound and vibration and

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might interfere with the pain gate system, thereby contributing to the relief of chronic pain.[7]

Music elicits emotions that are interpreted and modulated by the limbic system; thalamus; and brain areas associated with emotional behavior, such as the insula, cingulated cortex, hypothalamus, hippocampus, amygdala, and prefrontal cortex, which are also associated with motivation and reward pathways.[8,9]

Music may also induce physical signs and symptoms, including changes in respiration and heart rhythm,[10] as well as bodily sensations such as shivers and tremors.[11]

The tones emitted by the music can create the acoustic phenomenon known by binaural beat (Bb). This phenomenon requires the combined action of both ears. It exists as a consequence of the interaction of perceptions within the brain and can be used to investigate some of the brain's processes.[12] This psychoacoustic technique may establish specific neural rhythms that influence mood and sleep quality.[13,14]

Neurochemical studies have demonstrated that in addition to its tranquilizing effects, music increases the expression of chemical mediators (such as dopamine, endorphins, and endocannabinoids) and reduces interleukin levels.[15–17]

The vibratory stimuli perceived by the skin mechanoreceptors arrive at the somesthetic cortex via the gracile nucleus. Furthermore, other substances, including serotonin, catecholamines, and amino acids (such as glutamate and γ-aminobutyric acid), have been suggested as mediators of some of the cardiovascular and analgesic effects of acupuncture.[18] Moreover, nitric oxide–derived L-arginine in the gracile nucleus contributes to the neuronal response to eletroacupuncture.[19,20]

The present study analyzed the effect of music combined with vibration on acupuncture points in patients with FM to determine whether these procedures relieve the pain and improve the daily functions of the patients.

Materials and Methods

Patients

A prospective randomized, controlled trial was done in 120 women. These patients had been diagnosed with FM according to American College of Rheumatology criteria,[1] were 30 to 60 years of age, and had been undergoing the treatment recommended by the rheumatology service for a minimum of 6 months. Patients with diabetes mellitus, multiple sclerosis, alcoholism, polyneuropathy, kidney failure, asthma, emphysema, bronchitis, epilepsy, schizophrenia, or psychosis were excluded, as were patients who had difficulty lying supine, pregnant women, and individuals with hiatal hernias.

After providing informed consent, the patients were randomly allocated to four groups containing 30 patients each; the groups were subjected to different procedures. Randomization was made with a sequence of 120 numbers randomly generated in Excel (Microsoft Corp., Redmond, Washington), with values of 1–4; each number corresponds to a particular group previously without restrictions. The randomization was done by E.S.P., who was not involved in the study procedure. Each patient was placed in the dorsal decubitus position on a gurney, with blindfolds (opaque glasses) and earphones; vibration transducers were placed on the following five points, which are traditionally used in acupuncture to treat pain, anxiety, and sleep disorders: (1) IG-4 (64 Hz) on the right hand between the two metacarpi, (2) F-3 (32 Hz) on the left foot between the two metatarsi, (3) *yintang* (64 Hz) on the glabella between the eyes, (4) Ren-15 (48 Hz) on the tip of the xiphoid appendix, and (5) Ren-4 (32 Hz) on the pelvis (4 inches below the navel).[21]

The groups received the following procedures: (1) Control group: These patients wore the earphones and had the skin transducers fixed to the skin for 30 minutes, but no sound or vibration was applied. (2) Vibration group: Vibration was applied to the acupuncture points for 30 minutes, but no sound was played. (3) Music group: The earphones transmitted a musical sequence for 30 minutes, but no vibration was applied through the skin transducers, and the frequencies could not be heard through the earphones. The volume intensity of the music was adapted to each individual patient. (4) Complete group: This group listened to the music combined with binaural frequencies and was subjected to vibration applied through the skin transducers for 30 minutes.

The patients underwent the experimental procedure during five different sessions performed on every Tuesday, Thursday, and Saturday in the morning. They were assessed before the first session and 20 days after the last session.

The assessment was performed by using the following questionnaires: (1) The Fibromyalgia Impact Questionnaire (FIQ) assessed functional capacity, work status, psychological disorders, and physical symptoms and comprises 19 questions corresponding to 10 items. The total score ranges from 0 to 100; the higher the score, the greater the effect that FM has on quality of life.[22,23] (2) The Health Assessment Questionnaire (HAQ) assessed everyday functions and includes questions that evaluate the degree of difficulty and the necessity of assistance during everyday activities. The information on the degree of difficulty is elicited by 20 questions corresponding to eight categories related to specific activities and functional difficulties.[24]

The groups were homogeneous in their ages and disease durations (Table 1).

The Hospital de Clinicas da Universidade Federal do Parana reviewed and approved this project.

Table 1. Age and Disease Duration

Group	*Patients* (n)	*Age (y)*	*Disease duration (y)*
Control	30	48.3 ± 6.1	7.3 ± 3.8
		49.0 (30–56)	7.0 (2–19)
Vibration	30	49.1 ± 6.4	8.5 ± 5.6
		49.5 (33–60)	8.0 (2–30)
Music	30	46.6 ± 7.5	7.8 ± 6.6
		49.0 (31–56)	7.0 (2–40)
Complete	30	49.1 ± 4.30	8.5 ± 4.3
		49.0 (36–56)	8.0 (2–18)
p-Value		0.359 (ANOVA)	0.603 (Kruskal-Wallis)

Age and disease duration are expressed as mean ± standard deviation and median (minimum–maximum).

ANOVA, analysis of variance.

Table 2. Intragroup Comparison for Differences in Fibromyalgia Impact Questionnaire Scores After Treatment

Variable	*Group*	*Patients* (n)	*Mean ± SD*	*Median (minimum–maximum)*	p-*Value*[a]
Reduction in FIQ score obtained before and after treatment	Complete	30	20.72 ± 22.60	15.84 (−13.76 to 67.91)	0.160
	Control	30	9.93 ± 20.45	7.08 (−18.99 to 59.19)	
	Music	30	12.22 ± 19.12	7.65 (−13.25 to 62.12)	
	Vibration	30	8.77 ± 13.83	7.71 (−20.63 to 54.53)	

[a]Nonparametric Kruskal-Wallis; $p < 0.05$.
FIQ, Fibromyalgia Impact Questionnaire.

The device

The Vibro Music Stimulator (patent UM 8301851-4U) was used. This device consists of a program with various musical tones within a frequency range from 32 Hz (C1) to 128 Hz (C3). Those frequencies were conveyed to the skin at the acupuncture points through the above-described transducers, in addition to being combined with the music and heard through the earphones. The stimuli were intermittent (i.e., 1-minute vibration plus 10-second pause).

The music program comprised a sequence of classical Bach compositions: (1) *Brandenburg concerto no. 4 in G major—Presto (5.14)*; (2) *Brandenburg concerto no. 6 in B-flat major—Allegro (7.02);* (3) *Jesu, Joy of Man's Desiring in G—Moderato (2.27)*; (4) *Violin concerto in A minor— Andante (6.51)*; *(5) Air on the G string—Adagio (5.40)*.

The musical sequence lasted 30 minutes and presented a tempo that decreased from presto (168–200 beats per minute) to adagio (66–76 beats per minute). The compositions tonalities were harmonic (consonant sounds) and spatially symmetric on the skin (combination of points).[21,25,26]

The musical intervals that resulted from the differences between the frequencies and were perceived through the earphones induced the psychoacoustic phenomenon known as Bb.[12–14] The Bb of 16 Hz corresponded to the difference between the frequencies used (32 Hz, 48 Hz), which correspond to the acoustic interval of fifth and was related to the beta brain rhythm. This difference is perceived by the ears and the skin in combination of acupuncture points.

Statistical analysis

The results obtained in the study were described as mean, median, minimum, maximum values and standard deviations. To evaluate the homogeneity of the groups with respect to age, the model of analysis of variance with one factor was used. Regarding the duration of the disease, the nonparametric Kruskal-Wallis test was used. To compare the groups in relation to assessments with the FIQ and HAQ, the nonparametric Kruskal-Wallis test was performed. Nonparametric tests were chosen because the FIQ and HAQ are scores from discrete scales and meet the nature of the measures.

Upon rejection of the hypothesis of equality of the groups on the variable of interest, these groups were compared in pairs by using an extension of the Kruskal-Wallis test. To evaluate the effect of treatment within each group (before versus after), the nonparametric Wilcoxon test was used. Statistically significant differences were denoted by *p*-values < 0.05. Data were analyzed with Statistica software, version 8.0 (Dell Statistica, Tulsa, Oklahoma).

Results

Intragroup comparison in relation to the post-treatment differences in FIQ scores

Intragroup comparison of FIQ responses showed no significant differences ($p = 0.160$) between scores obtained before and after the procedure (Table 2).

Comparison of the FIQ scores before the first session and after the last session revealed a significant reduction in all the groups, including the control group (Table 3). However, the degree of significance was higher in the complete group (i.e., the combination of music and vibration modalities) ($p < 0.001$), although the music group and vibration group exhibited remarkable reductions.

Intragroup comparison in relation to the differences in HAQ scores after treatment

Intragroup comparison of HAQ responses showed a significant difference ($p = 0.036$) between scores obtained before and after (Table 4).

Table 3. Influence of Vibration, Music, and Combined Procedure on Fibromyalgia Impact Questionnaire Scores

Group	*Patients (n)*	*Before*	*After*	p-*Value (Wilcoxon)*[a]
Control	30	76.93 ± 11.44 78.84 (50.28–97.67)	67.01 ± 23,62 72.10 (13.62–98.34)	0.035
Vibration	30	68.10 ± 16.30 69.01 (27.33–95.02)	59.33 ± 20.88 62,02 (11.66–89.81)	0.001
Music	30	71.75 ± 15.36 74.23 (14.76–91.59)	59.53 ± 21.67 60,70 (15.86–93.67)	0.024
Complete	30	74.49 ± 17.28 78.17 (12.76–98.67)	53.76 ± 23.29 55.81 (11.62–93.91)	< 0.001

Before and after scores are expressed as mean ± standard deviation and median (minimum–maximum).
[a]Intragroup assessment of the treatment effect.

Table 4. Intragroup Comparison of Differences in Health Assessment Questionnaire Scores After Treatment

Variable	*Group*	*Patients (n)*	*Mean ± SD*	*Median (minimum–maximum)*	p-*value*[a]
Reduction of HAQ score obtained before and after treatment	Complete	30	0.49 ± 0.56	0.38 (−0.75 to 2.00)	0.036
	Control	30	0.14 ± 0.40	0.13 (−1.13 to 1.38)	
	Music	30	0.28 ± 0.52	0.19 (−0.63 to 1.63)	
	Vibration	30	0.37 ± 0.56	0.31 (−0.38 to 2.13)	

[a]Nonparametric Kruskal-Wallis; $p < 0.05$.
SD, standard deviation; HAQ, Health Assessment Questionnaire.

Evaluation of the treatment effect on the HAQ within each group

Intragroup comparison of the HAQ scores before the first session and after the last session revealed a significant reduction in all groups, including the control group ($p = 0.016$), the results of which were identical to those in the vibration group. The scores of the complete group and music group were even lower, especially in the former, which was subjected to a combination of music and vibration ($p < 0.001$) (Table 5).

On the basis of the significant reduction ($p = 0.036$) in the HAQ score within groups before the first session and after the last session, the final scores of the groups were subjected to pairwise comparisons (intergroups). Only the comparison between the control group and the complete group yielded a significant difference (Table 6).

Discussion

Several methods may be used to stimulate acupuncture points, including needles, friction, light, heat, electricity, vibration, and music. Because acupuncture mechanisms of action are not yet fully elucidated, the misguided notion that clinical results are mainly due to the placebo effect has arisen. The clinical trials on the efficacy of acupuncture exhibit many methodologic limitations because, as in the case of other nonpharmacologic interventions, models of inert and indistinguishable controls and placebos are difficult to create. However, recent studies do suggest acupuncture has some effect on physiology.[27–30]

The present study used a mechanical sound wave in combination with music. The main skin mechanoreceptors associated with the perception of vibration are the Meissner corpuscles (MCs) and the Paccinian corpuscles (PCs). The PCs generate action potentials following vibratory stimulation of 50–800 Hz.[31] The MCs and PCs are rapidly adapting receptors (i.e., they respond quickly and subsequently adapt to stimuli).[32] To avoid this adaptation to the vibration and sound frequencies emitted by the device, the stimuli were applied intermittently. Intermittent stimulation hinders the development of adaptation and maintains the receptors in an activated state.[33]

The improvement in the FIQ and HAQ scores after the application of synchronized vibratory and musical stimuli might have occurred because of the combination of the stimuli, which is similar to the binaural effect generated by the difference between frequencies. Bb occurs when tones with different frequencies are simultaneously heard through earphones.[12] This psychoacoustic technique could entrain specific neural rhythms and influence brain activity.[13,14] Moreover, an appropriate selection of classical music may be used to induce relaxation and reduce sympathetic activity.[10]

The present results also suggest that the placebo effect is quite remarkable, as all of the groups exhibited a significant improvement. However, the intragroup comparison revealed that the complete group exhibited the greatest reduction in both FIQ and HAQ scores ($p < 0.001$) mainly on the HAQ, for which the difference was significant ($p < 0.004$). This finding suggests that the combined use of music and vibration exerted the largest effect on the symptoms of FM. Because FM is caused by abnormalities in the processing of pain in the central nervous system, including central sensitization and inadequate pain inhibition, the combination of music and vibration in acupuncture points may modulate the perception of pain in the brain and stimulate the antinociceptive system.[34]

Table 5. Influence of Vibration, Music, and the Combined Procedure on Health Assessment Questionnaire Scores

Group	*Patients (n)*	*Before*	*After*	p-*Value (Wilcoxon)*[a]
Control	30	1.75 ± 0.49 1.88 (0.75–2.63)	1.61 ± 0.51 1.75 (0.63–2.38)	0.016
Vibration	30	1.75 ± 0.46 1.75 (0.87–2.50)	1.38 ± 0.64 1.38 (0.00–2.75)	0.015
Music	30	1.85 ± 0.38 1.81 (0.88–2.50)	1.56 ± 0.44 1.50 (0.63–2.38)	0.008
Complete	30	1.93 ± 0.47 2.00 (0.75–2.50)	1.44 ± 0.67 1.63 (0.38–2.38)	< 0.001

Before and after scores are expressed as mean ± standard deviation and median (minimum–maximum).

Table 6. Intergroup Comparison of Improvement in Health Assessment Questionnaire Scores

Compared groups	p-*Value*[a]
Complete vs. control	0.004
Complete vs. music	0.098
Complete vs. vibration	0.294
Control vs. music	0.211
Control vs. vibration	0.064
Music vs. vibration	0.541

[a]Nonparametric Kruskal-Wallis; $p < 0.05$.

The fact that the best results were obtained via the combination of music and vibration might have a phylogenetic connotation because the human ear evolved from the organ of balance in primitive fish; this corresponds to the lateral line displayed by aquatic vertebrates. The lateral line detects vibrations or changes in the pressure of the water. Although the lateral line disappeared during the evolution of reptiles, the special mechanical sensitivity of the hair cells was adopted and adapted to the internal ear structures.[5] The lateral lines presents a linear arrangement of receptors on the body surface, similar to those of acupoints and meridians described in the human body in Chinese medicine.[35]

In conclusion, the current data indicate that music and vibration exhibit beneficial effects for the short-term treatment of FM. However, the placebo effect was also important. Further studies are necessary for investigating different frequencies and musical sequences, including comparisons with other methods of stimulating acupuncture points and assessments of the long-term efficacy via brain-function imaging methods. In brief, the Vibro Music Stimulator is a noninvasive, functional, and easily applicable treatment option with high patient adherence.

Author Disclosure Statement

Dr. Weber holds the patent for the Vibro Music Stimulator equipment used in this work. Dr. Werneck is the recipient of a productivity grant from CNPq, Brazil. This research was approved by the Ethical Committee for Research on Humans of the Hospital de Clínicas da Universidade Federal do Paraná.

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