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Effects of Vibroacoustic Therapy on Elderly Nursing Home Residents with Depression

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Abstract. [Purpose] The objective of this study was to investigate whether vibroacoustic therapy (VAT) could improve the psychological symptoms of 15 elderly nursing home (NH) residents with symptoms of depression. [Methods] Fifteen subjects received VAT for 30 minutes per day for 10 days. Depression was evaluated using the Dementia Mood Assessment Scale (DMAS). Tympanic temperature, pulse, blood pressure, and SpO_2 were measured as physiological indexes of relaxation. In addition, sleep-wake rhythms of the 15 subjects were evaluated using actigraphy. [Results] Based on DMAS scores, mitigation of depression was observed in NH residents after receiving VAT. Moreover, significant decreases in tympanic temperature and pulse were observed after treatment. Total sleeping hours per day showed a significant decrease when mean sleeping hours in the first week were compared with the mean sleeping hours in the second week. [Conclusion] VAT provided relaxation effects for elderly NH residents, and improved depressive symptoms.
Key words: Vibroacoustic therapy, Nursing home resident, Depression

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INTRODUCTION

The prevalence of depression among elderly nursing home (NH) residents is very high[1)]. No matter how depression is defined, the prevalence rates are three to five times higher among NH residents than among the community-dwelling elderly[1, 2)]. If untreated or inadequately treated, or patients are unresponsive to treatment, depression can lead to adverse health outcomes such as malnutrition, poor hydration, weakening from physical inactivity, functional decline, decreased quality of life, and ultimately, death[3)]. Moreover, depression is the greatest risk factor for increasing cognitive dysfunction in persons with mild cognitive impairment[4)]. Depression appears to be a major health problem among elderly NH residents[2, 5)].

Vibroacoustic therapy (VAT), which was proposed by Skill[6)] in 1989, is attracting increasing attention for its therapeutic effects, and the first World Congress of Vibroacoustic Therapy was held in Croatia in 2008. Standly[7)] reported that VAT, which combines “listening to music” with vibrotactile stimulation, resulted in deeper relaxation effects compared with “listening to music” alone. In addition, Lundqvist et al.[8)] reported that VAT is effective for reducing self-injurious, stereotypic, and destructive behaviors among those with developmental disabilities.

The efficacy and safety of low-frequency vibratory sound stimulation were first investigated[9)] using the PC12m3 cell line developed by Kano et al.[10)] The PC12m3 cell line is a mutant cell line derived from the neuron model cell line, PC12, developed by Greene[11)]. PC12m3 cells exhibit poor neurite outgrowth in response to nerve growth factor (NGF). Cells treated with NGF show enhanced neurite outgrowth in response to various stimulants, such as calcium ionophore, immunosuppressant FK506, and heat shock[12)]. Applying low-frequency vibration with a frequency range 20–150 Hz to PC12m3 cells for 30 minutes resulted in a significantly higher frequency of neurite outgrowth compared with a control group ($p<0.01$) due to activation of the p38MAPK signaling pathway[9)].

In particular, the frequency of neurite outgrowth induced by 40-Hz low-frequency vibratory sounds was approximately three-fold greater than that of neurite outgrowth seen in the control group. Because the vibroacoustic device (Symphony; Sanei Co., Ltd., Tokyo, Japan) used in the present study is a vibration transducer that transforms the low-frequency components of 20–150 Hz, which is almost the same frequency band used in our previous experiments, into vibrations, the device is expected to best reflect the efficacy and safety of our previous studies.

The objective of this study was to investigate whether VAT could improve psychological symptoms in 15 elderly NH residents with symptoms of depression.

SUBJECTS AND METHODS

The subjects were 15 elderly NH residents (5 males, 10 females; 86.3 ± 7.8 years) who showed superficial psychological symptoms of depression (Dementia Mood Assessment Scale [DMAS] score, mean ± SD: 49.66 ± 16.17). The objectives and procedures of the study were explained to all subjects as well as to their families. This project was approved by the Ethics Committee of the Prefectural University of Hiroshima, and all subjects provided their informed consent.

The subjects received VAT for 30 minutes every day, except for Saturdays and Sundays, for 2 consecutive weeks. The Symphony device is a mattress-type vibroacoustic device that separates audio signals from music into two lines. Auditory music from one of the lines is heard from two flat 40-W speakers embedded in the mattress near the right and left sides of the head. The other line isolates low-frequency components (20–150 Hz) and reproduces them as vibrational stimuli via six vibration transducers (a device converting electrical signals into mechanical vibrations) embedded in the mattress near the shoulder, waist, and femoral region. VAT was performed from 15:30 to 16:00 based on the data of Smallwood et al.[13] who showed that aromatherapy and massage given during that time period were most effective for patients with dementia. Our previous study also indicated that a 30-minute period was most effective for PC12m3 cells. Classical music was used based on studies reporting that classical music transiently leads to improved cognition in both normal elderly patients and those with dementia[14].

Sadness and depression were examined using the DMAS[15]. The DMAS is a 24-item (score, 0–144) observational scale used to rate mood and functional abilities on an objective basis. The first 17 items are designed to measure mood in cognitively impaired subjects and the last seven items to measure cognitive and functional impairment. The mood subscale has a maximum score of 102 with a higher score representing greater dysphoria. Sunderland et al.[16] reported that scores were significantly correlated with global measures of depression (r=0.73) and sadness (r=0.65), and inter-rater reliability was highly satisfactory.

Cognitive performance was assessed using the Mini Mental State Examination (MMSE; score, 0–30) [17], which has been used worldwide to examine the severity of cognitive performance.

Behavioral disturbances were assessed using the Dementia Behavior Disturbance (DBD; score, 0–168) scale[18]. A 28-item DBD scale was developed to avoid some of the problems encountered with the older instrument. Each of the 28 items was designed to be used in an interview format, with the patient's primary caregiver as the respondent. Each behavior was rated on a Likert-type scale with five possible responses corresponding to the frequency of the behavior in the preceding week (0=never, 4=all the time). Thus, higher scores indicate more disturbances. The reliability and validity of the Japanese version of the DBD scale has previously been established[19].

For each patient, DMAS, MMSE, and DBD were recorded at the same time, before VAT treatment and after 2 weeks of treatment.

Physiological responses assessed included tympanic temperature, percutaneous oxygen saturation (SpO_2), blood pressure, and pulse rate. Tympanic temperature was measured using a TERUMO ear-type thermometer (EM-30 CPL; TERUMO Co., Ltd., Tokyo, Japan). Measurements were carried out on weekdays over 2 consecutive weeks (total, 10 times). Triplicate measurements were performed for each measurement after 5 minutes of bed rest immediately after VAT. The highest value was used in the analysis. SpO_2 levels were measured with a finger pulse oximeter (EPOCH 30; Ubi-X Co., Ltd., Tokyo, Japan). Measurements were carried out on weekdays over 2 consecutive weeks (total, 10 times). Measurement of BP and pulse were conducted using an OMRON digital automatic wrist-type sphygmomanometer (HEM-632; OMRON Co., Ltd., Kyoto, Japan).

Sleeping hours were measured using wristwatch-type actigraphy (Micromini RC; Ambulatory Monitoring Inc., Ardsley, NY). This actigraph has been reported to show 90% or better agreement with sleep polygraphy[20]. This instrument records gravitational acceleration of as little as 0.01 G with pressure sensors in three directions along the X, Y, and Z axes, and discriminates between sleep and wake from the amount of activities during gravitational acceleration; it uses sleep-wake distinction software approved by the American Academy of Sleep Medicine[21]. The Sadeh A algorithm was used as a discriminant[22, 23]. Measurements were made for 16 days, except during bathing, from 1 day before VAT until 1 day after VAT ended. A circaseptan rhythm is a cycle consisting of 7 days in which many biological processes of life resolve, for example blood pressure and heart rate[24–26]. Therefore this test was used to determine each patient's circaseptan rhythm.

Data were statistically analyzed using SPSS software (version 16.0, SPSS, Chicago, IL). The Wilcoxon signed-rank test was used to determine significant differences in physiological responses (tympanic temperature, SpO_2, BP, and pulse) before and after VAT, and sleep-wake time (total sleep time, wake time and nighttime sleep) of first week and second week. The significance level was chosen as 0.05.

RESULTS

DMAS, DBD and MMS: The DMAS, DBD, and MMSE scores before and after VAT are shown in Table 1. A significant improvement in depression as assessed by DMAS was noted ($p<0.05$). In addition, a significant improvement in depression and sadness as assessed by items 1 to 17 of DMAS was found ($p<0.05$). No significant improvements were seen in the DBD or MMSE scores.

Physiological responses: Significant decreases ($p<0.001$) in tympanic temperature and pulse rate were observed after VAT. No significant changes in blood pressure and SpO_2 were observed (Table 2).

Sleep Time: Mean total sleep time in the second week significantly decreased compared with the first week ($p<0.05$) (Table 3). Furthermore, when mean wake times between the first and second weeks were compared, a significant increase was noted in the second week ($p<0.05$). However no sig-

Table 1. Effect of vibroacoustic therapy (VAT) on cognitive function, behavioral symptoms, and psychological symptoms

	Before VAT (mean ± SD)	After VAT (mean ± SD)
MMSE	19.40 ± 7.21	19.0 ± 7.58
DBD	25.93 ± 10.45	25.26 ± 13.51
DMAS (total on 24 items)	49.66 ± 16.17	43.8 ± 17.93*
Depression and sadness (DMAS; items 1-17)	36.66 ± 11.13	32.93 ± 14.05*
Overall dementia severity (DMAS; items 18-24)	12.33 ± 7.22	10.86 ± 7.68

n=15, *：p<0.05. MMSE, Mini Mental State Exam; DBD, Dementia Behavior Disturbance scale; DMAS, Dementia Mood Assessment Scale

Table 2. Effect of vibroacoustic therapy (VAT) on physiological responses

	Before VAT (mean ± SD)	After VA (mean ± SD)
Tympanic temperature (ºC)	36.46 ± 0.47	36.31 ± 0.53***
SpO_2 (%)	95.3 ± 2.5	95.08 ± 2.77
Pulse (beats/min)	72.28 ± 9.88	70.66 ± 9.44***
Blood pressure (systolic) (mmHg)	139.16 ± 24.96	138.56 ± 24.17
Blood pressure (diastolic) (mmHg)	73.04 ± 14.43	73.29 ± 14.81

n=15, ***p<0.001

Table 3. Effect of vibroacoustic therapy (VAT) on sleep-wake rhythm

	First week (Mean ± SD)	Second week (Mean ± SD)
Total sleep time (min)	626.54 ± 221.35	599.61 ± 216.55*
Nighttime sleep (min)	346.41 ± 174.21	347.8 ± 172.28
Nighttime sleep efficiency (%)	88.64 ± 8.33	89.28 ± 9.76
Wake time (min)	813.45 ± 221.35	838.06 ± 217.48*

n=15, *p<0.05

nificant improvements were seen in terms of nighttime sleep minutes and nighttime sleep efficiency.

DISCUSSION

The heart rate is governed by the autonomic nervous system, and the autonomic nervous system is regulated by the opposing activities of the sympathetic and parasympathetic systems. Variability in heart rate is known to reflect the balance of the autonomic nervous system. When the sympathetic nerve system dominates, heart rate increases, and when the parasympathetic nerve system dominates, heart rate decreases. The sympathetic nerve system dominates during periods of stress, whereas the parasympathetic system dominates during periods of relaxation.

In the present study, heart rate of the 15 elderly NH residents was significantly reduced (p<0.0001) after VAT. This result suggests that VAT induced parasympathetic system effects. In addition, tympanic temperature of the 15 elderly NH residents was significantly reduced (p<0.001) after VAT. Tympanic temperature reflects the internal carotid artery temperature[27)]. Calasso M et al. reported that the temperatures of the common carotid artery and the ear pinna decrease during rapid eye movement (REM) sleep[28)]. Their results support our observation that VAT induced relaxation in the elderly NH residents.

Approximately 80% of patients with depression complain of changes in sleep patterns. Sleep disorders in depression are mainly insomnia and hypersomnia. Hypersomnia (over 600 minutes of total sleep time per day) may be the main symptom of some depressive disorders, such as seasonal depression, depression with atypical features or depressive episodes in bipolar disorder[29)]. Total sleep hours of the 15 subjects in this study (mean 626.54 ± 221.35 minutes) significantly decreased after VAT (mean 599.61 ± 216.55 minutes). However, nighttime sleep (mean 346.41 ± 174.21 minutes) and nighttime sleep efficiency (88.64 ± 8.33%) were not affected by VAT. Consequently, wake times significantly increased (p<0.05) after VAT. These results suggest that the improvement of depression increases wake time in the daytime.

A significant improvement in sadness and depression as assessed by the DMAS was shown in the 15 elderly NH residents (p<0.05) after 2 weeks of VAT. Overall, these findings suggest that VAT induced relaxation in the elderly NH residents with symptoms of depression.

Blumenthal reported that aerobic exercise is an effective treatment for depression in the elderly, being comparable to that of antidepressant drugs[30)]. In studies on intracellular transduction pathways during aerobic exercise using mouse muscle cells, Akimoto reported on a pathway in which MKK3/MKK6 in MAPKK is activated by aerobic exercise, leading to the activation of downstream p38αMAPK, and eventually to mitochondria biosynthesis[31]. In our previous studies, in which the effects of low-frequency vibratory sound were investigated using the PC12m3 cell line, we found that MKK3/MKK6 in MAPKK was activated by low-frequency vibratory sounds at 20–150 Hz, leading to the activation of p38MAPK downstream in MAPK[9]. Together, these reports suggest that VAT has an effect similar to aerobic exercise through activation of the p38MAPK pathway.

Falempin et al. suggested that tendon vibration (120 Hz) applied to rat soleus muscle can be used as a strategy to counteract the atrophic process observed after hindlimb unloading[32]. In addition, Skill reported that vibroacoustic music (30–120 Hz) reduces muscle tone and spasms[6]. Mitigation of depression by VAT in the elderly NH residents in this study might have been caused by vibrotactile stimuli, which may have represented passive aerobic exercise. Furthermore, the p38MAPK signaling pathway has been reported to have protective effects on cardiac muscle[33].

In summary, the results of this study suggest that VAT stimulation activated the p38MAPK signaling pathway, eventually leading to mitochondria biosynthesis in muscle cells. As a result, VAT led to relaxation in the elderly NH residents. It is possible that VAT may have the potential to decrease depression in elderly NH residents. Future, well-controlled studies are needed to confirm these findings.

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