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Effect of olfactory stimulation with essential oils on cardiovascular reactivity during the moving beans task in stroke patients with anxiety

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ABSTRACT

Objective: To investigate the effect of olfactory stimulation with essential oils on cardiovascular reactivity during the "moving beans" rehabilitation task in stroke patients with anxiety.
Methods: Twenty-eight stroke patients participated in this study. Blood pressure and heart rate were measured before and after finger movement tasks (e.g., moving beans and the Purdue pegboard test). Olfactory stimulation with lavender oil, grapefruit oil, and distilled water were conducted during finger tasks. Anxiety was assessed using the State Trait Anxiety Inventory (STAI)-Y2 before the finger movement tasks.
Results: There were no significant changes in blood pressure or heart rate activity in both finger movement tasks when stimulation of lavender oil, grapefruit oil, and distilled water was applied. However, the change values of Δ diastolic blood pressure (DBP) associated with the moving beans task indicated a significant interaction between olfactory stimulations and the groups of STAI-Y2 scores (high vs low) ($p = 0.03$), without main effects in the olfactory stimulations and the groups of STAI-Y2 scores.
Conclusion: Olfactory stimulation with lavender and grapefruit oil may repress the exaggerated DBP response during the moving beans task in stroke patients with higher levels of trait anxiety symptoms.

1. Introduction

Stroke has been shown to lead to depressive disorders and anxiety disorders, as well as having other emotional consequences.[1] The prevalence of generalised anxiety disorder in the acute stage of stroke was 28%, and there was no significant decrease during the 3-year follow-up.[2] Anxiety disorder is often associated with a significant increase in blood pressure (BP) during stress stimuli.[3] Cardiovascular reactivity reflects underlying sympathetic nervous system activation and has been shown to vary according to individual characteristics (e.g., personality factors and emotions)[4] and is shown to be influenced by certain psychological characteristics.[5] BP management after onset of stroke is associated with reduction of stroke recurrence or vascular events.[6] Based on all of this information, it is concluded that cardiovascular reactivity during stress stimulation should be carefully monitored in stroke patients with anxiety disorder. Additionally, a previous study reported that trait anxiety is one of important risk factors for stroke.[7] Trait anxiety refers to a relatively stable characteristic of personality.[8] Differences in behaviour of individuals with low-trait anxiety and high-trait anxiety under stress conditions have also been reported.[9] Further, cortisol responses to stress were related to self-confidence, which is strongly contingent upon trait anxiety.[9] Therefore, it is possible that differences in cardiovascular reactivity during stress are dependent on an individual's level of trait anxiety.

Conventionally, stroke patients participate in an exercise programme for their rehabilitation, such as physical therapy, occupational therapy, and/or speech therapy. Previous studies have elucidated the effect on BP and heart rate (HR) in stroke patients based on this exercise programme. Functional walk tests, such as the 6-min Walk Test, increased systolic BP (SBP) by about 16 mmHg, diastolic BP (DBP) by about 2 mmHg, and HR by about 29 bpm compared with rest periods in stroke patients.[10] Bicycle ergometer exercise at 4 METs significantly increased SBP by 79 mmHg in stroke patients.[11] On the other hand, in speech therapy, the therapist-directed approach substantially increased both SBP and DBP in stroke patients with aphasia,[12] the so-called "white coat effect".[13] Similar to these cases, an increased BP during occupational therapy for stroke patients is predicted.

The moving beans task (MBT) with chopsticks training has been used in the rehabilitation, particularly in occupational therapy, for dominant hand disorder in stroke patients.[14] In a previous study, we

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reported that MBT with chopsticks while using the non-dominant hand for 5 min increased SBP, DBP, and mean BP (MBP) in healthy subjects.[15] It is predicted that MBT with stressful finger task exaggerates cardiovascular reactivity in stroke patients due to age-related changes in autonomic nervous regulation and underlying diseases. Therefore, it is important to repress the exaggerated cardiovascular reactivity as much as possible during MBT.

Previous studies have also shown the effect of aromatherapy, like olfactory stimulation, on cardiovascular reactivity. Aromatherapy with inhaled essential oils had a positive effect on reducing anxiety, increasing quality of sleep, and stabilising BP in patients in a cardiovascular intensive care unit after cardiac stent insertion.[16] Olfactory stimulation with lavender oil scent has been shown to repress BP responses in rats.[17] It is expected that olfactory stimulation with essential oils may help to stabilise mood or emotions of stroke patients who show symptoms of anxiety, as well as help to repress cardiovascular reactivity associated with MBT. However, there is no report regarding the effect of olfactory stimulation with essential oil on cardiovascular reactivity of stroke patients. The aim of our study was to investigate the effect of olfactory stimulation with essential oils on cardiovascular reactivity during MBT in stroke patients, and to verify whether cardiovascular reactivity during MBT differs depending on the level of trait anxiety in stroke patients.

2. Materials and methods

2.1. Subjects

Twenty-eight patients (12 females and 16 males; mean age, 68.2 years [SD, 13.3]) who were diagnosed with stroke and admitted to the inpatient convalescent ward were enrolled in this study. Inclusion criteria for participation in this study were as follows: (1) hemiplegia of dominant hand from stroke for at least 1 month after stroke onset; (2) medically stable for at least 1 week after stroke onset; and (3) normal olfactory function. Patients were excluded if they had other medical conditions that would prevent participation in the programme. All subjects provided written consent for participation and were provided an opportunity to refuse inclusion in the research. The study protocol was reviewed and approved by the Ethics Committee of Tohoku Fukushi University (RS1308221).

2.2. Baseline survey

Occupational therapists assessed the sociodemographic profiles and medical profiles in the baseline survey. This consisted of the following details in sequence: (1) age, (2) sex, (3) body mass index, (4) number of family members, (5) occupation, (6) activities before onset, (7) dominant hand side, (8) type of stroke, (9) location of brain damage, (10) paralysed side, (11) time since stroke, (12) history of illness, (13) use of antihypertensive drugs, (14) consciousness (Japan Coma Scale score),[18] (15) Barre arm sign, (16) upper limb function (Brunnstrom recovery stage of the upper limb),[19] (17) tendon reflex of biceps brachii, (18) sensation of palm, (19) pain of upper limb, (20) ataxia, (21) range of motion of upper limb joints, (22) muscle tone of upper limb (Modified Ashworth scale),[20] (23) agnosia, (24) apraxia, (25) aphasia, (26) cognitive function (mini-mental state examination),[21] and (27) activities of daily living (functional independence measure).[22]

2.3. Experimental procedure

Two types of finger tasks, the MBT and the Purdue pegboard test (PPT), were performed by all subjects in a quiet room. Both tasks were done in random order on a different day. The protocol was composed of the control phase (5-min rest period and 30-s MBT or PPT) and stimulation phase (after the control phase; 5-min rest period and 30-s MBT or PPT with olfactory stimulation). In this study, a 30-s trial was set based on the methods of previous reports on the performance of MBT in the elderly[23] and the change of BP responses during PPT in the hypertensive subjects,[24] considering the first attempt of olfactory stimulation for stroke patients and the burden on the stroke patients of the elderly.

Lavender and grapefruit essential oils (Takasago International Corporation, Japan) were used as the olfactory stimulus, and distilled water was used as the control stimulus during the finger tasks of each subject. The order of the oil and distilled water trial exposures were randomly selected for each subject. For the stimuli, an investigator held a paper stick, previously dipped in either one of the oils or in distilled water, within a few centimetres of, but not touching, the right side of the subject's nose.[25]

2.4. Experimental tasks

2.4.1. MBT

The subjects used chopsticks with their non-dominant hand to transfer as many beans as possible from one dish (2.0 cm in depth, 20.0 cm in diameter) to another (3.5 cm in depth, 6.0 cm in diameter) within 30 s[23] The dishes were placed at a distance of 20 cm apart.

2.4.2. PPT

PPT is used as an assessment of fine motor speed and dexterity of the dominant hand, non-dominant hand, and of both hands simultaneously.[26] PPT is a validated test of manual dexterity and eye-hand coordination.[27] It consists of a board (approximately 30.5 cm × 45.5 cm), with two parallel rows of 25 holes each.[27] Pegs are located at the top of the board in wells that are to the left of the board and one to the right of the board.[27] The peg board was situated at midline in front of the subject's body. For the purposes of our study, the subject picked up one peg at a time out of a well with the non-dominant hand and then placed each peg in a hole in the row. This was done consecutively, as many times as possible within 30 s.

2.5. Cardiovascular measurements

Subjects sat in a normal chair, with arms relaxed and resting on the table. BP and HR were measured twice, i.e., during the last 5 min of the rest period and then again after the finger movement task using an automatic digital BP meter (HEM- 7051-HP; OMRON HEALTHCARE Co., Ltd., Kyoto, Japan) on the non-dominant upper arm at the level of the heart. BP and HR were measured during both the control phase and the stimulation phase.

2.6. Trait anxiety symptoms

All subjects received the self-reported questionnaire, the State Trait Anxiety Inventory (STAI)[28] Y-2. The STAI consists of 20 items to measure how a subject generally feels anxiety as a personality characteristic on a four-point Likert scale (1–4), with potential total scores ranging from 20 to 80.[28] The STAI Y-2 assessment measures trait anxiety, with higher scores indicating greater levels of trait anxiety. STAI is considered to have high inner coherence reliability and validity, when compared with clinical diagnosis.[29]

2.7. Statistical analysis

The mean values of BP and HR during the 5-min rest period before MBT and PPT were used as baseline data. Cardiovascular change values (Δ), which were calculated by subtracting respective baseline data from data after finger movement tasks, were used as the cardiovascular reactivity elicited by the finger movement task. Change values of cardiovascular reactivity, which were calculated by subtracting respective Δ of the control phase from Δ of the stimulation phase, indicated the effect of olfactory stimulation on cardiovascular reactivity associated