

## [Original Article]

# Improvement of Sleep and Circadian Rhythm Disturbance in Nursing Home Residents by Aromatherapy Massage: A Preliminary Study

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## [ABSTRACT]

We examined the effect of aromatherapy massage on the circadian rhythm in 8 elderly subjects in an open semi-comparative trial, comparing the parameters in the 2<sup>nd</sup> week during which the aromatherapy massage sessions were performed, with 1-week periods (1<sup>st</sup> and 3<sup>rd</sup> weeks) before and after the sessions. Time spent asleep while in-bed and the sleep efficiency during the sleep time increased significantly in the 2<sup>nd</sup> week compared with those in the 1<sup>st</sup> and/or 3<sup>rd</sup> weeks. A higher peak of the 24-h cycle circadian rhythm was noted following aromatherapy massage in elderly people, who often exhibit circadian rhythm disturbance. Furthermore, the peaks of the spectrum cycle in the 2<sup>nd</sup> week were significantly closer to 24 h than those in the 1<sup>st</sup> and 3<sup>rd</sup> weeks. These results suggest that aromatherapy massage improves sleep and circadian rhythm disturbance.

## [Key words]

elderly people, sleep disturbance, circadian rhythm disturbance, actigraph, aromatherapy massage

## INTRODUCTION

Elderly persons often suffer from circadian rhythm disturbance and insomnia. In particular, patients with dementia complain of strong circadian rhythm disturbance including insomnia and disturbed behaviors.

For circadian rhythm disturbance, several treatments have been applied. Although administrations of melatonin<sup>1)</sup>, a melatonin receptor agonist (Ramelteon)<sup>2)</sup>, and bright light therapy<sup>3)</sup> have been attempted, beneficial effects have not always been achieved.

Aromatherapy is one of many complementary and alternative medicines used to treat various diseases and symptoms, as essential oils exhibit many kinds of pharmacological actions including anti-microbial, sedative, analgesic, spasmolytic, and estrogen or steroid hormone-like effects, etc<sup>4)</sup>. Since various kinds of essential oil such as true lavender, rose, mandarin, sweet orange, sandalwood, geranium, etc., exhibit anxiolytic activities, aromatherapy has been used for the relief of depression and anxiety.

We have reported that aromatherapy massage helped to reduce state anxiety and depression in healthy subjects<sup>5)</sup>, improved mild depression<sup>6)</sup>, and reduced anxiety and ameliorated the immunological state in breast cancer patients in an open semi-comparative trial<sup>7)</sup>.

Furthermore, in addition to the reduction of anxiety and improvement of the depressive state, the sedative effect of essential oils is well-known, as well as their sleep-promoting

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effects<sup>8</sup>). Therefore, aromatherapy may help to improve sleep disturbance in elderly persons. Due to behavioral disturbance, patients with dementia often have marked difficulties in sleeping, and so aromatherapy may be particularly useful for them. In fact, aromatherapy has been used for people with dementia to reduce disturbed behavior<sup>9–15</sup>, promote sleep<sup>16,17</sup>, stimulate motivational behavior<sup>18</sup>, and improve cognitive function<sup>19</sup>.

Thus, there have been many studies on the effects of aromatherapy massage on sleep and behavioral disturbance. However, there have been few studies on the effects of aromatherapy massage on circadian rhythm disturbance, which is frequently observed in elderly persons.

One method of measuring the sleep state and circadian rhythm is by monitoring activity levels. This can be done through the use of an actigraph, a motion-sensing device the size of a watch worn on the wrist and comprised of an accelerometer, a microprocessor, and 32 K of retrievable memory. Actigraphy is a simple, non-invasive method of measuring levels of day- and nighttime activity, and can be used for the precise estimation of the amounts of both day- and nighttime sleep. In addition, activity patterns over several consecutive days can be analyzed employing autocorrelational techniques to provide estimates of sleep state and circadian rhythms<sup>20,21</sup>.

In the present study, we examined the effect of aromatherapy massage on the sleep and circadian rhythm including activity, time spent awake/asleep during the day- and nighttime, and spectrum analysis of actigrams in nursing home residents.

## METHODS

### Subjects

This study was performed in 2007 and 2008. The subjects were selected from residents of the Mam Cuore Elderly People's Nursing Home, Kyoto, Japan, according to the following criteria:

- A. Inclusion criteria
  1. Subjects aged 70–85
  2. Judged to suffer from sleep disturbance
  3. Judged to suffer from circadian rhythm disturbance
- B. Exclusion criteria
  1. Patients with disturbed consciousness
  2. Patients allergic to essential oils used in this study

This study was conducted after obtaining approval from the

ethics committee of the nursing home. We gave detailed explanations of the project to each subject or their legal representatives, and all subjects or their respective legal representatives signed informed consent forms prior to participating.

### Study design

We designed this study as an open semi-comparative trial, which means that the one-week periods before and after aromatherapy massage were control periods. We compared the parameters in these periods with the one-week period during which aromatherapy massage sessions were undertaken.

### Carrier and essential oils

Joboba oil was purchased from Meadows (Canterbury, UK). Lavender oil (*Lavandula angustifolia*), geranium oil (*Pelargonium graveolens*), and chamomile roman oil (*Anthemis nobilis*) were purchased from Laboratoire Sanoflore (Gigore-et-Lozeron, France). About 0.1 ml of lavender oil, 0.05 ml of geranium oil, and 0.05 ml of chamomile roman oil were mixed with 8 ml of jojoba oil. It has been documented that these essential oils have a sedative effect to promote sleep<sup>4,8</sup>.

### Tests for dementia

We used the Mini-Mental State Examination (MMSE)<sup>22</sup> and Dementia Behavior Disturbance (DBD) Scale<sup>23</sup> for evaluation of the state of dementia. Furthermore, we evaluated self-maintaining activity (a guideline proposed by the Japanese Ministry of Health, Labour and Welfare in 1991). Self-maintaining activity references two metrics: severity of dementia, and activities of daily living (ADL). The severity of dementia was classified into I (slightest), IIa, IIb, IIIa, IIIb, IV, and M (most severe), and the ADL were ranked J (slight disturbance, not requiring the help of a caregiver), A1, A2 (mild, requiring the help of a caregiver only when he or she leaves the home), B1, B2 (moderate, requiring the help of a caregiver even in the home), and C1 and C2 (severe, requiring the help of a caregiver in all settings).

### Actigraph

The actigraph is a simple, noninvasive method of measuring levels of day- and nighttime activity, and can be used for an accurate estimation of the levels of both day- and nighttime sleep<sup>20,21</sup>. Therefore, the objective and exact circadian rhythm disturbance including sleep disturbance was judged using an actigraph, and compared to a sleep diary alone.

Subject activity was sampled using an actigraph over a continuous 3-week period (Mini-Motionlogger Actigraph; Ambulatory Monitoring, Ardsley, NY, USA). Motion, or lack thereof, was recorded once per min during this time period. The three variables were generated by the company's

companion analysis program, Action-W2, which separates the day into an 'up' or 'out-of-bed' portion of the day and a 'down' or 'in-bed' portion. The names and significance of the variables used in this study are shown in Table 2. The % sleep was calculated using following formula: % sleep = (asleep

**Table 1** Profile of subjects

Gender	Female	Female	Male	Male
Age	81	71	83	85
Clinical diagnosis	Alzheimer's disease, diabetes mellitus, hypertension, post-operation for rectal cancer	Intracerebral hemorrhage, post-subdural hematoma, cervical cancer, neurogenic bladder, lymphedema of the lower extremities	Multifocal cerebral infarction, neurogenic bladder, osteoarthritis	Narrow spinal canal, paresis of right upper extremity
DBD	14	11	38	30
MMSE	3	22	20	17
Self-maintaining activity	B2, IV	A2, IIb	B1, IIIa	B2, IIIa
Gender	Female	Female	Female	Female
Age	81	77	82	75
Clinical diagnosis	Cerebral infarction, left hemiplegia	Hypertension, osteoporosis	Rheumatoid arthritis	spinal infarction, hypertension
DBD	10	1	8	13
MMSE	21	21	21	21
Self-maintaining activity	B1, I	A2, I	A2, IIa	B2, J

Self-maintaining activity references two metrics: severity of dementia, and activities of daily living (ADL). The severity of dementia was classified into I (slightest), IIa, IIb, IIIa, IIIb, IV, and M (most severe), and ADL was ranked classified J (slight disturbance, not requiring the help of a caregiver), A1, A2 (mild, requiring the help of a caregiver only when he or she leaves the home), B1, B2 (moderate, requiring the help of a caregiver even in the home), and C1 and C2 (severe, requiring the help of a caregiver in all settings).

DBD: Dementia Behavior Disturbance Scale

MMSE: Mini-Mental State Examination

**Table 2** Variables, their definition, and significance of actigraphic measures

Variable	Definition	Significance	
		Sleep disturbance	Circadian rhythm disturbance
Duration	Minutes from start to end of interval	Down: shorter	
Activity mean	Mean activity score (counts/epoch)	Up: lower Down: higher	
Awake minutes	Total minutes scored as awake	Down: longer Up: shorter	
Asleep minutes	Total minutes scored as asleep	Down: shorter Up: longer	
% Sleep	Percent minutes scored sleep (100*Sleep/Duration)	Down: lower Up: higher	
Sleep efficiency	(100* Sleep minutes/(O-O Duration))	Down: lower	
Wk after slp onset	Awake minutes during O-O interval	Down: longer	
Rhythm pattern	(Mean activity × duration out of bed)/(Mean activity × duration in bed)		Lower
Peak power around 24 h	Peak Power of spectrum cycles around 24 hours		Lower
Peak power between 20 and 28 h	Peak Power of spectrum cycles between 20 and 28 hours		Lower
Power ratio	Ratio of specific spectrum power to total spectrum power		Lower
Proximate value to 24 h	Proximate value closest to 24 hours of maximum peak of spectrum cycle		Longer

minutes/duration in bed) × 100.

The sleep efficiency was calculated using following formula: sleep efficiency = (asleep minutes/duration from sleep onset to out of bed) × 100.

The rhythm pattern was calculated using the following formula: Rhythm pattern = (mean activity × duration out of bed)/(mean activity × duration in bed).

Furthermore, actigraph data was analyzed by the maximum entropy method using MemCalc/Win software (V. 1.2) (GMS, Tokyo, Japan), and the power peaks of the spectrum cycles between 20 and 28 h, and those around 24 h were calculated. The ratio of the specific spectrum power to the total spectrum power and the proximate value closest to 24 h of the maximum peak cycle were also calculated (Table 2).

### Procedure of aromatherapy massage

The subjects received a 30-min aromatherapy massage around 1 h before going to bed twice in the 2<sup>nd</sup> week. Each subject received the same standardized massage involving the back, shoulders, arms, hands, and upper legs for approximately 30 min performed by licensed and skilled therapists just before going to bed.

### Statistical analysis

We examined differences in data between the 1<sup>st</sup> and 2<sup>nd</sup> weeks and between the 2<sup>nd</sup> and 3<sup>rd</sup> weeks using the paired t-test. Temporal changes in variables were examined using repeated measures ANOVA and the Bonferroni test. All statistical analyses were conducted using SPSS software (Advanced Models 14.0J). p-values less than 0.05 were considered significant.

## RESULTS

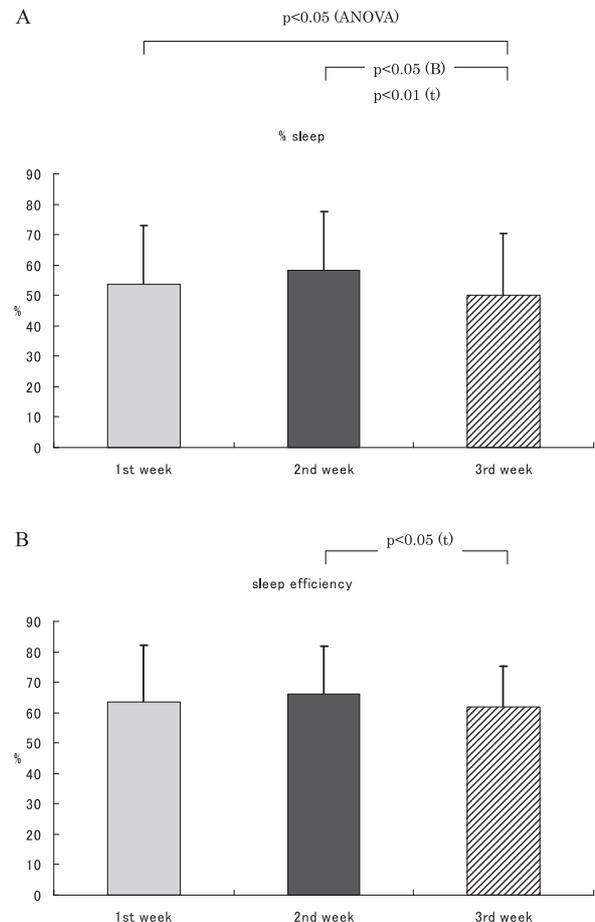
### Profile of subjects

Eight subjects, aged 71–85 years, (2M/6F), were enrolled into the present study (Table 1). In the MMSE, 7 of the subjects showed scores of approximately 20, with a score of 3 for the subject with Alzheimer's disease. In the DBD test, 6 subjects showed disturbed behavior. The subjects had the diseases shown in Table 1.

### Effects on sleep disturbance

The subjects wore actigraphs continuously for 3 weeks. In the 2<sup>nd</sup> week, the subjects received aromatherapy massage twice.

The data obtained from actigraphs were analyzed using AW2 software, and the variables “% sleep” and “sleep efficiency” were calculated. There was a significant difference in the “% sleep” among the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> weeks on repeated measures ANOVA ( $p < 0.05$ ), and a significant difference between the 2<sup>nd</sup> and 3<sup>rd</sup> weeks ( $p < 0.05$ , Bonferroni) (Fig. 1A). The “% sleep” tended to increase in the 2<sup>nd</sup> week compared



**Fig. 1** Effects of aromatherapy massage on the sleep disturbance in nursing home residents.

Subject activity was sampled for a continuous 3-week period using the Mini-Motionlogger Actigraph. Variables were generated by the company's companion analysis program, Action-W2, which separates the day into an 'up' or 'out-of-bed' portion of the day and a 'down' or 'in-bed' portion. The % sleep was calculated using following formula: % sleep = (asleep minutes/duration in bed) × 100. The sleep efficiency was calculated using following formula: sleep efficiency = (asleep minutes/duration from sleep onset to out of bed) × 100.

A: %sleep

B: Sleep efficiency

□ 1<sup>st</sup> week

■ 2<sup>nd</sup> week

▨ 3<sup>rd</sup> week

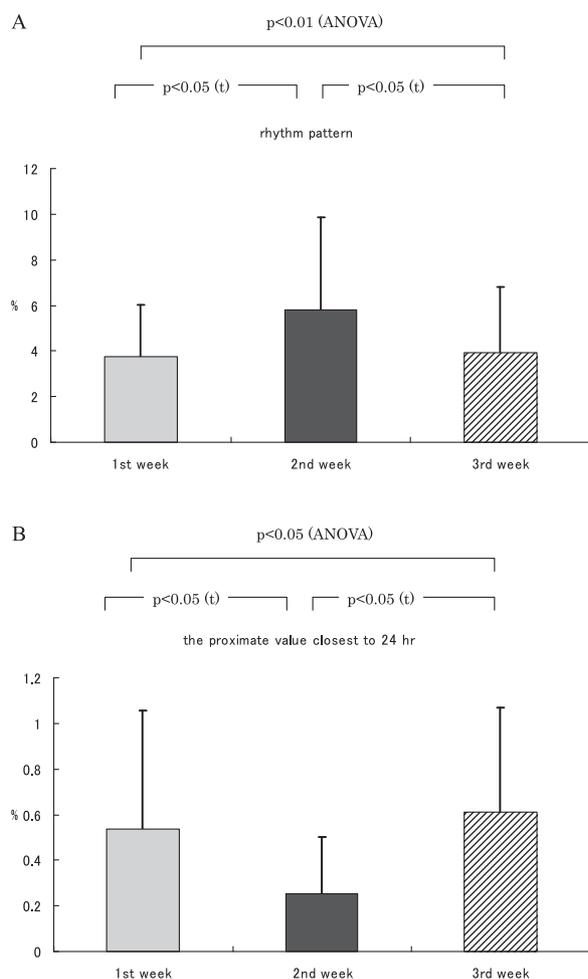
ANOVA: repeated measures ANOVA

B: Bonferroni test

t: Paired t-test

with that in the 1<sup>st</sup> week, and decreased significantly in the 3<sup>rd</sup> week compared with that in the 2<sup>nd</sup> week ( $p < 0.01$ , paired t test).

The “sleep efficiency” tended to increase in the 2<sup>nd</sup> week



**Fig. 2** Effects of aromatherapy massage on the circadian rhythm disturbance in nursing home residents.

Subject activity was sampled for a continuous 3-week period using the Mini-Motionlogger Actigraph. Variables were generated by the company’s companion analysis program, Action-W2, which separates the day into an ‘up’ or ‘out-of-bed’ portion of the day and a ‘down’ or ‘in-bed’ portion. The rhythm pattern was calculated by employing the following formula: Rhythm pattern = (mean activity × duration out of bed)/(mean activity × duration in bed).

Furthermore, the data obtained from actigraphs were analyzed by the maximum entropy method using MemCalc/Win software (V. 1.2) (GMS, Tokyo, Japan), and the proximate value closest to 24 h of the maximum peak cycle was also calculated.

A. Rhythm pattern

B. Proximate value closest to 24 h of the maximum peak cycle.

□ 1<sup>st</sup> week

■ 2<sup>nd</sup> week

▨ 3<sup>rd</sup> week

ANOVA: Repeated measures ANOVA

t: Paired t-test

compared with that in the 1<sup>st</sup> week, and decreased significantly in the 3<sup>rd</sup> week compared with that in the 2<sup>nd</sup> week ( $p < 0.05$ , paired t-test) (Fig. 1B).

### Effects on circadian disturbance

Next, the effects of aromatherapy massage on circadian disturbance were examined. Namely, the rhythm pattern was calculated as an index of the circadian rhythm (sleeping/wakefulness pattern). The results showed that there were significant differences in the rhythm pattern among the 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> weeks on repeated measures ANOVA ( $p < 0.01$ ), between the 1<sup>st</sup> and 2<sup>nd</sup> weeks ( $p < 0.05$ , paired t-test), and between the 2<sup>nd</sup> and 3<sup>rd</sup> weeks ( $p < 0.05$ , paired t-test) (Fig. 2A).

Next, the data obtained from actigraphs was analyzed using MemCalc software. The main peaks of cycles were around 24, 16, 12, 8, 6, 3, and 1 h, although 150 to 160 cycle peaks were obtained. The peak power of a cycle around 24 h was maximal. Namely, in general, healthy persons show a peak power of the cycle around 24 h which is about 40–70% of the peak power of whole spectrum cycles, whereas our subjects showed rates of 2.52–50.30%. The peak powers of cycles between 20 and 28 h and those around 24 h tended to be higher in the 2<sup>nd</sup> week than those in the 1<sup>st</sup> and 3<sup>rd</sup> weeks (data not shown).

The proximate values closest to 24 h were calculated to examine the effect on circadian rhythm. There were significant differences in the proximate value closest to 24 h among the 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> weeks on repeated measures ANOVA ( $p < 0.01$ ), and between the 1<sup>st</sup> and 2<sup>nd</sup> weeks ( $p < 0.05$ , paired t-test) and between the 2<sup>nd</sup> and 3<sup>rd</sup> weeks ( $p < 0.05$ , paired t-test) (Fig. 2B).

## DISCUSSION

Aromatherapy can benefit elderly people with or without dementia who complain of sleep and circadian rhythm disturbance. We examined the effect of aromatherapy massage on circadian rhythm disturbance in subjects with or without dementia in an elderly nursing home.

The “% sleep” and “sleep efficiency” tended to increase in the 2<sup>nd</sup> week and decreased significantly in the 3<sup>rd</sup> week compared with the 1<sup>st</sup> week, indicating the possibility of sleep promotion by aromatherapy massage. There have been many reports that aromatherapy promotes sleep and ameliorates behavioral disturbance<sup>9–19</sup>, and our results are in agreement with these studies.

In addition, there were significant differences in the “rhythm pattern” between the 1<sup>st</sup> and 2<sup>nd</sup> weeks, and between the 2<sup>nd</sup> and

3<sup>rd</sup> weeks, which suggests that the sleeping/wakefulness pattern is improved by aromatherapy massage.

In the present study, the analysis of data obtained from actigraphs using MemCalc software showed that the peak powers of cycles between 20 and 28 h and around 24 h tended to be higher in the 2<sup>nd</sup> week than those in the 1<sup>st</sup> and 3<sup>rd</sup> weeks. Furthermore, the peaks of the spectrum cycle in the 2<sup>nd</sup> week were significantly closer to 24 h than those in the 1<sup>st</sup> and 3<sup>rd</sup> weeks. These results suggest that aromatherapy massage ameliorates circadian rhythm disturbance. We believe this is the first report in which the improving effect of aromatherapy massage on circadian rhythm disturbance was confirmed *via* an objective methodology using actigraphs.

However, further investigations with an increased sample size and improved study design, including a control group, are required to confirm our results. Further, because the degrees of DBD and MMSE of the subjects varied widely, it is necessary to study subjects with a similar severity of dementia. To facilitate this, it is important to identify a therapy suitable for the control.

In conclusion, our results suggest that aromatherapy massage is a viable complementary therapy that significantly reduces circadian rhythm disturbance in nursing home residents.

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## 要 旨

### 老人保健施設入所者におけるアロマセラピー・マッサージの睡眠およびサーカディアンリズム障害の改善効果—パイロット研究

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われわれは、アロマセラピー・マッサージのサーカディアンリズムに対する効果を8名の高齢者について、オープン比較試験において検討した。すなわち、アロマセラピー・マッサージを行う1週間前(第1週目)、アロマセラピーを行った第2週目、アロマセラピー終了後1週間の第3週目の睡眠障害およびサーカディアンリズムを、アクティグラフを用いて比較検討した。その結果、就床時の睡眠率(% sleep)および睡眠中の睡眠効率(sleep efficiency)は、第1週および第3週と比較して、第2週では有意に増加することがわかった。24時間のサーカディアンリズム周期のパワーピークはアロマセラピー・マッサージ後に有意に増加し、サーカディアンリズム障害が改善されることがわかった。さらに、第2週におけるスペクトラムサイクルのピークも第1週および第2週に比較して24時間により近くなっていた。これらの結果は、アロマセラピー・マッサージが高齢者における睡眠障害およびサーカディアンリズム障害を改善することを示唆している。

**キーワード** : 高齢者, 睡眠障害, サーカディアンリズム障害, アクティグラフ, アロマセラピー・マッサージ