Original Article

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The effects of instruction regarding sleep posture on the postural changes and sleep quality among middle-aged and elderly men: A preliminary study

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Summary **The purpose of this study was to examine whether instruction to sleep in a lateral posture prior to falling asleep could increase the frequency of instructed posture and sleep quality, as evaluated by sleep parameters and a questionnaire for subjective assessment of sleep. The participants were comprised of 8 middle-aged and elderly men who had an awareness of their habitual snoring during sleep. Data were gathered from observations of sleep posture, sleep polysomnography and a subjective sleep quality questionnaire. As a result of the instruction, the frequency of the instructed posture was significantly increased, and there were no significant effects on sleep parameters or the frequency of postural changes. The subjective sleep quality during the instructed sleep showed worse scores than free postural-sleep for all factors. Our findings suggest that the instructed sleep posture could be increased during sleep without substantially worsening the sleep parameters and the frequency of postural changes. Future studies will therefore be required to clarify the mechanism and the long-term effects of such instruction on sleep posture, including the influence on subjective sleep quality.**

Keywords: Instruction of sleep posture, postural change, sleep parameters, subjective sleep quality

1. Introduction

Body movements during sleeping are classified as minor movements and major movements based on the amplitude using the static charge method (*1*). Change in sleep posture, or rolling over, is included in the major movements, which are accompanied by a transfer of the center of gravity. It is reported that the type and frequency of major movements differ significantly from individual to individual (*1*).

Rolling over is defined as a Postural Change during Sleeping (PCS). PCS is considered to have a physiological function, such as enhancing blood circulation and avoiding or decreasing the pressure on certain areas of the body. It is thought to be possible to regulate body temperature and moisture in bed by the physiological function of anti-side diaphoresis and PCS (*2*). Furthermore, PCS converges just before Rapid Eye Movement (REM) and the latter part of the REM phase (*3*). PCS is considered to be an important factor for REM; PCS enhances the transition from the waking stage to the sleeping stage, and is related to the procession and sustaining mechanism of the sleep cycle (*4*,*5*). As a result, there have been numerous reports regarding the physiological effects and roles of PCS.

When PCS is accompanied by large movements of the trunk, head and pelvis, it sometimes causes an awakening reaction on the electroencephalogram (EEG), thus indicating the presence of an alpha wave and light sleep; however, the short term awareness between a few and ten seconds during sleep are not remembered. PCS is generally accomplished

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unconsciously, and the trunk direction is unconsciously decided. Therefore, fixing the body in a compulsory manner seems to be a reliable method when a client's PCS should be controlled for the treatment of certain diseases.

It is reported that the apnea-hypopnea-index among patients who have sleep apnea syndrome, especially obstructive sleep apnea, shows improvement in the lateral posture rather than the supine posture (*6*,*7*). Therefore, an increase in the rate of lateral sleep posture would help prevent an apnea event, and some studies have reported interventions for controlling sleep posture using physical methods (*8-10*). These studies reported that the parameters of a sleep polysomnograph between intervention nights and controlled nights showed no differences. However, the compulsory intervention in sleep posture could have an effect on the frequency of PCS and subjective sleep quality.

A previous study examined the time that participants sustained the instructed posture during sleep when the sleep posture was instructed prior to sleep (*11*). It was suggested that the instruction could influence sleep posture, and that the instruction would be the easiest way to control sleep posture for the participants who had a general ability to understand and communicate without the need for physical restraint or other compulsory methods. Furthermore, sleep posture could be improved without interfering with the various natural roles of PCS. However, the previous study was not able to clarify the effects of instruction of sleep posture on sleep quality. Therefore, the purposes of the present study were *i*) to clarify the instruction of sleep posture prior to sleep which could increase the rate of the instructed posture during sleep and *ii*) to clarify the effect of instructed posture toward sleep quality, including such factors as sleep parameters and subjective sleep quality.

2. Materials and Methods

2.1. *Participants*

The participants were recruited in a Silver Human Resources Center or by a snowball sampling method. The participants were 8 males aged 51 to 72 (mean ± S.D.: 63.1 ± 6.9, median: 64.5). They had awareness of snoring during sleep, had no treatment history for sleep disorders, and were not using medication that affected the central nervous system. The average body mass index (BMI) was 25.2 ± 4.1 kg/m^2. Four out of 8 participants were smokers (Table 1). We targeted middle-aged and elderly men because their sleep structures were more susceptible due to aging and sex (*12*), because it has been shown that aging is a risk factor for Sleep Disordered Breathing (SDB), and an increase in incident prevalence until 60 years of age was also reported (*13*). Sleep disorders among women were most likely accompanied by menopause (*14*) and the ratio of insomnia per capita among women who were aged 50-70 and older surpasses that of their male counterparts (*15*).

Table 1. Demographics and characteristics of participants

	Mean ± S.D. [range] or *n* (%) (*n* = 8)
Age (years)	63.1 ± 6.9 [51-72]
Height (m)	1.68 ± 0.09 [1.57-1.84]
Weight (kg)	71.0 ± 13.4 [54-95]
BMI (kg/m^2)*	25.2 ± 4.1 [21.1-34.1]
Current smoker	4 (50)
Drinking (days/week)	4 or more:5 (62.5), 0:3 (37.5)
Awareness of snoring	Often:7 (87.5), sometimes:1 (12.5)

* BMI: body mass index.

A full explanation of all procedures and possible outcomes was given to the participants, and written informed consent was obtained from each participant. This research was reviewed by the Research Ethics Committee of Saitama Prefectural University.

2.2. *Schedule and environment of the experiments*

Participants were evaluated during a consecutive 3 night experimental session. The authors developed a schedule that sustained the participants' habits, such as time for awakening, going to bed, meals and bathing. Participants arrived at the laboratory 3.5 h earlier than their usual schedule for going to bed, and polysomnography electrodes were attached after having dinner (3 h before going to bed). Participants were prohibited from consuming alcoholic and caffeinated beverages after they entered the laboratory. They answered the questionnaire about sleep quality after waking up at the scheduled time, and wore a wrist actigraph device (Micro-Mini Actigraph; Ambulatory Monitoring Inc., Ardsley, NY, USA). They were allowed to do anything they wanted except for taking naps and engaging in intense exercise during the daytime.

During the sleep period, an environmental control chamber (Tabai Espec, Tokyo, Japan) was used to maintain the level of temperature and humidity at levels based on the guidelines from the Healthcare Engineering Association of Japan (26.0°C, 50% RH) (*16*). Normal bedclothes were used, a mattress was put on the floor in the experimental room, and a cotton blanket was used for cover.

2.3. *Measurement items and procedures*

2.3.1. *Sleep posture*

Sleep posture was recorded with an infrared video camera (TK-N1100; Victor, Kanagawa, Japan) between going to bed at night and rising the next morning. The first night was the acclimation night, and participants were informed to roll over freely. For the second and third nights, the subjects were randomly provided instructions for sleep posture using a cross-over method: some patients received instructions the second night, others received them the third night. During the instructed sleep (Instruction-S), the patients were asked to: 'Please sleep in a lateral position as much as possible, it doesn't matter which side' and 'Please keep in a lateral position as much as possible while sleeping'. Meanwhile, free postural-sleep (Free-S) was defined as when the participants slept in their preferred posture.

2.3.2. *Sleep polysomnography*

EEGs were read using a mono-polar C3, C4, and Fpz parts based on the Ten Twenty Electrode System of the International Federation (*17*) and recorded with a Digital Multiuse Electroencephalograph (SYNAFIT5000; NEC Digital Systems, Tokyo, Japan). Electrooculography (EOG) was performed for both eyes, electromyography (EMG) was monitored for the mentalis muscle (both sides) and electrocardiography (ECG) (led between the right shoulder and left subclavicular) was also recorded at the same time. Data were gathered from the time when the subject went to bed until arising the next morning.

2.3.3. *Subjective sleep quality and sleep habit*

The subjective assessment of sleep states was measured with the Oguri-Shirakawa-Azumi sleep survey sheet- Middle Age and Aged edition (OSA-MA edition) (*18*), and a sleep onset questionnaire (*19*). The OSA-MA edition was a short form, targeting middle-aged and elderly people, revised by Yamamoto *et al.*, and based on the OSA sleep survey sheet, second edition (*20*) to estimate the subjective sleep profile that was developed by Oguri *et al.* The OSA-MA edition was scored using 5 factors with 16 items and 4 scales. Those five factors were *1*) sleepiness on rising (4 items), *2*) initiation and maintenance of sleep (5 items), *3*) frequent dreaming (2 items), *4*) feeling refreshed (3 items) and *5*) sleep length (2 items). A sleep onset questionnaire, revised by Yamamoto *et al.*, was a sociological estimation of sleep onset from going to bed and remaining asleep. In this experiment, the 9 items that estimate a sleep onset profile in the questionnaire were used because instructions just before sleep onset could possibly affect the sleep onset profile.

Participants confirmed that they had not traveled anywhere with a time difference of more than 5 h and had not engaged in night shift work within one month prior to the study. Their usual sleep and wake patterns were recorded using the wrist actigraph while they had worn the device on their non-dominant hand beginning one week before the experiment and throughout the experimental period. Participants responded to a Sleep Health Risk Index (SHRI) (*21*) and a questionnaire about habitual sleep posture that was originally developed by the authors. The SHRI, developed by Shirakawa *et al.*, aimed at clarifying sleep health risk by categorizing the degrees of risk for sleep health into 5 factors and scoring them (*21*). Another questionnaire about the awareness of posture during sleep was originally developed by the authors. It asked them about their awareness of their usual sleep postures of sleep onset and during sleep, then asked them why they slept in that posture.

The participants' awake states during the experimental night were measured using the wrist actigraph. Participants were asked about their awareness of posture during sleeping, such as sleep posture at sleep onset on each experimental night, and about the sleep posture that they were aware of most frequently during sleep.

2.4. *Analysis*

2.4.1. *Sleep posture and PCS*

Sleep postures recorded on video-tape were categorized visually in the following 4 directions based on the scapulas' direction: if participants slept on their back, it was defined as *i*) supine when the angle between the acromions and the mattress was between 0 to 45 degrees, *ii*) lateral sleep posture when the angle was between 45 to 90 degrees, if participants slept on stomachs, it was defined as *iii*) a lateral sleep posture when the angle was between 45 to 90 degree, and *iv*) prone when and the angle was between 0 to 45 degree (Figure 1). The categorization was done by one of the authors. The obtained data were analyzed every second and the duration of sustained posture was accumulated. The frequency of PCS was counted when a certain posture was sustained for more than 10 sec. Sleeping posture was analyzed for the whole night and it was divided into first half and second half sleep phases and the phases were compared.

2.4.2. *Sleep polysomnography*

Data were analyzed every 30 sec based on the International Classification of Sleep Process (Stage 1, 2, 3, 4, REM, Wake stage) (*22*). The first nights' data were excluded from the whole 24 nights' data of sleep polysomnography because of first night effects. Data from three participants was excluded from the analysis, because the data detection was incomplete or impossible to analyze. Therefore, data from a total of 10 nights were analyzed.

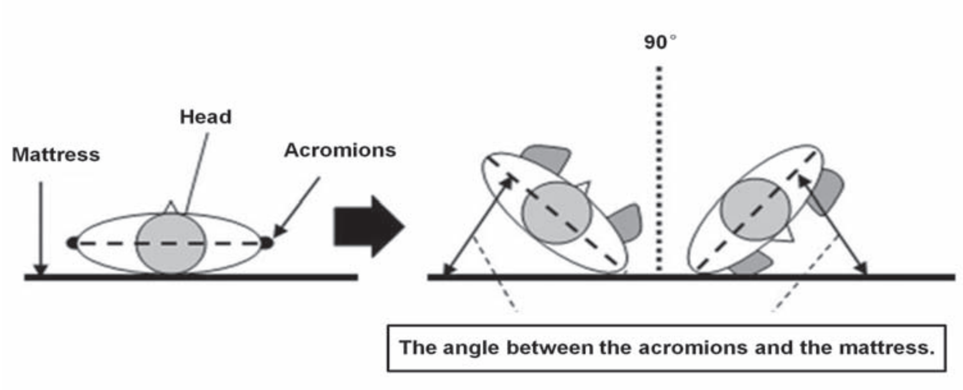

Figure 1. The categorization of sleep posture. The scapulas' direction: the angle between the acromions and the mattress. 0-45 degree, supine or prone; 45-90 degree, right or left lateral.

2.4.3. *Subjective sleep quality and sleep habit*

The OSA-MA edition was plotted in an MS-Excel sheet for converting sleep profile scores, and the results were analyzed based on the scores for 5 factors. In this process, high scores were judged as good sleep quality. Standard rating scales to estimate sleep onset were utilized as a sleep onset questionnaire and high scores were judged as good sleep onset quality.

Data that was consecutively recorded as activity level every 1 min with the wrist acitgraph were analyzed using a statistical software program with a specific interface, and the results were divided into sleep and awake phases based on the method reported by Cole *et al.* (*23*).

2.4.4. *Statistical analysis*

The SPSS 11.0J for Windows software package (SPSS Japan Inc., Tokyo, Japan) was used as a statistical tool. After excluding the first night data, Instruction-S and Free-S were compared. The paired *t*-test was used for comparisons of the sleep parameters. The Wilcoxon signed-rank sum test was used for the comparison of position rates, frequencies of PCS and subjective sleep quality data. Spearman's rank correlation coefficients were calculated to analyze the relationship of various parameters with the frequencies of PCS. The level of significance was set at $p < 0.05$.

3. Results

3.1. *Instructions and sleep postures*

The duration of each posture was calculated each night (mean ± S.D.). As a result, the supine position was used 64.9 ± 21.4% of the time, and the lateral posture accounted for 35.1 ± 21.4% of the first night, and for Free-S, the supine position was used 56.0 ± 18.2% and the lateral posture was used 43.7 ± 18.2% of the time. For Instruction-S, the supine position was used 14.2 ± 9.0% and lateral posture was used 85.8 ± 9.0% of the time. The prone posture was only used for 11 min in one participant's Free-S. The duration of the lateral posture thus increased during Instruction-S compared to Free-S among all 8 participants. The increase was 42.1 ± 12.5% (mean ± S.D.), which was a significant difference ($p = 0.012$). Figure 2 shows the rate of lateral posture after receiving instructions. The filled circle and the solid line represents the rate of lateral posture in 5 men whose polysomnographs were analyzed, and the open circle and the dotted line represents 3 men who were excluded.

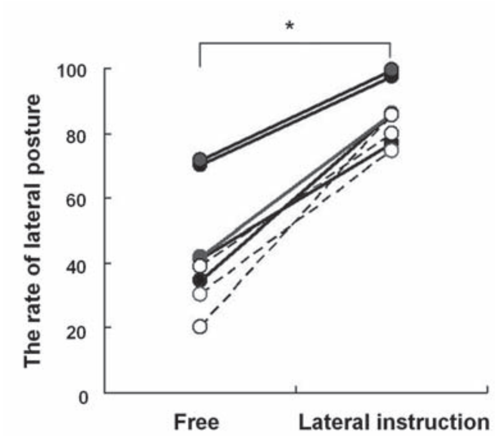

Figure 2. The rate of lateral posture [%] according to the presence of instructions; the change in each subject. The filled circle and the solid line represented the rate of lateral posture in 5 men whose polysomnographs were analyzed, and the open circle and the dotted line represented 3 men who were excluded. Wilcoxon signed-rank sum test; * $p < 0.05$.

Supine and lateral postures were compared based on sleep phases and whether instructions were given to the subjects. The duration (mean ± S.D.) of sleep postures between the first and second halves of sleep phases were compared. As a result, the supine position was used during the first half 61.0 ± 14.9% of the time, while it was used 51.2 ± 28.1% in the second half. The lateral posture during the first half was used 38.4 ± 14.8% of the time, and was used 48.8 ± 28.1% of the time when no instructions were given. Meanwhile, the supine position was used 12.4 ± 8.2% of the time and

16.5 ± 15.2% of the time in the first and second halves, while the lateral posture was used 87.6 ± 8.2% and 83.5 ± 15.2% of the time when subjects were instructed to sleep in a lateral position. The rates between the halves were not significantly different, regardless of whether or not instructions had been given.

3.2. *Instructions for sleep posture and the frequency of PCS*

The frequency of PCS (mean ± S.D.) per hour was analyzed separately when the instructions were given and not given. We observed that the frequency of PCS for Free-S was 2.2 ± 2.0 times/h while the frequency of PCS with Instruction-S was 2.2 ± 1.6 times/h. There were no statistically significant differences between the frequency of PCS with and without instructions. However, there were wide variations among participants during the first night, with a PCS frequency ranging from 0.4 times/h to 6.1 times/h, and there was a significant correlation between the frequency of PCS with and without instructions (r = 0.862, p = 0.006).

The frequency of PCS was also compared between the first and the second halves of sleep phases (mean ± S.D.). The frequency of Free-S for the first half was 1.9 ± 2.0 times/h, the frequency of Free-S for the second half was 2.4 ± 2.2 times/h, the frequency with Instruction-S for the first half was 1.8 ± 1.3 times/h and the frequency with Instruction-S for the second half was 2.7 ± 2.3 times/h. There were no statistically significant differences between the frequency of PCS during the first and second halves of sleep, regardless of whether instructions were given.

3.3. *Sleep postures and sleep parameters*

The rate of lateral posture during sleep in 5 men whose polysomnographs were analyzed and 3 men who were excluded were compared. No statistically significant difference was observed between the groups in terms of Instruction-S (p = 0.13) and Free-S (p = 0.06).

Table 2 shows each sleep parameter compared with and without instructions. There were no statistically significant differences between the parameters among the participants who slept with and without instructions. Figure 3 shows an example of sleep stages and postural changes that were extracted from a participant's final nights of Free-S (Figure 3a) and Instruction-S (Figure 3b). The participant went to bed with the instructed posture, and moved on to the third and fourth stages still sustaining the instructed posture.

The rate of sleep stages such as the first, second, third and fourth (Slow Wave Sleep: SWS), and REM sleep were analyzed with the exclusion of the times for not being in bed and being awake. The rates of each sleep stage were not significantly different between the Instruction-S and Free-S sleep. The rates of each sleep stage were compared for supine and lateral postures on each experimental night. There were no statistically significant differences between the rates of sleep stages with supine and lateral postures of Free-S, while the rates of SWS for the lateral posture significantly increased compared to the supine position (p = 0.04) when subjects were part of the Instruction-S group (Table 3).

3.4. *Subjective sleep quality and sleep habits*

Activities and rest in the daytime within the experimental terms were also recorded by the wrist actigraph. The length of activities in the daytime for sleep without instruction (mean ± S.D.) was 214.5 ± 25.3 min, and was 215.5 ± 27.0 min for Instruction-S, and the length of rest in the daytime for Free-S was 21.4 ± 35.9 min, while that for Instruction-S was 19.0 ± 24.9 min.

Scores of the OSA-MA edition were calculated separately for five factors. A higher score indicates a better quality of sleep. These scores were compared between sleep with and without instructions. The average scores for Instruction-S were lower than that for Free-S for all factors. The data of 5 men whose

Table 2. Comparison of various nocturnal sleep parameters in the presence of instructions

Parameter	Free[a]	Instruction[a]	p-value[†]
Time In Bed (min)	492.8 (14.5)	492.4 (13.9)	0.74
Total Sleep Time (min)	406.1 (46.0)	412.5 (25.9)	0.67
Waking After Sleep Onset (min)	74.2 (49.1)	61.1 (30.8)	0.41
Sleep Latency (min)	11.4 (7.3)	17.9 (14.7)	0.25
Sleep Latency to Stage 2 (min)	1.0 (2.0)	1.4 (2.0)	0.10
Sleep Latency to REM (min)	74.1 (41.9)	69.3 (34.9)	0.81
Sleep Period Time	480.3 (14.0)	473.6 (12.2)	0.29
Sleep Efficiency (%)	82.5 (10.6)	3.9 (7.3)	0.66
% Awake	15.4 (10.1)	12.8 (6.4)	0.43
% of Stage 1	7.7 (4.3)	7.7 (4.7)	0.99
% of Stage 2	45.8 (15.0)	44.8 (13.3)	0.70
% of SWS	13.2 (12.4)	17.1 (10.4)	0.29
% of REM	17.9 (5.3)	17.6 (7.6)	0.91

All values are the means (S.D.). [a] n = 5 for each group; [†] paired t-test. SWS, slow wave sleep (stage 3 and 4); REM, rapid eye movement.

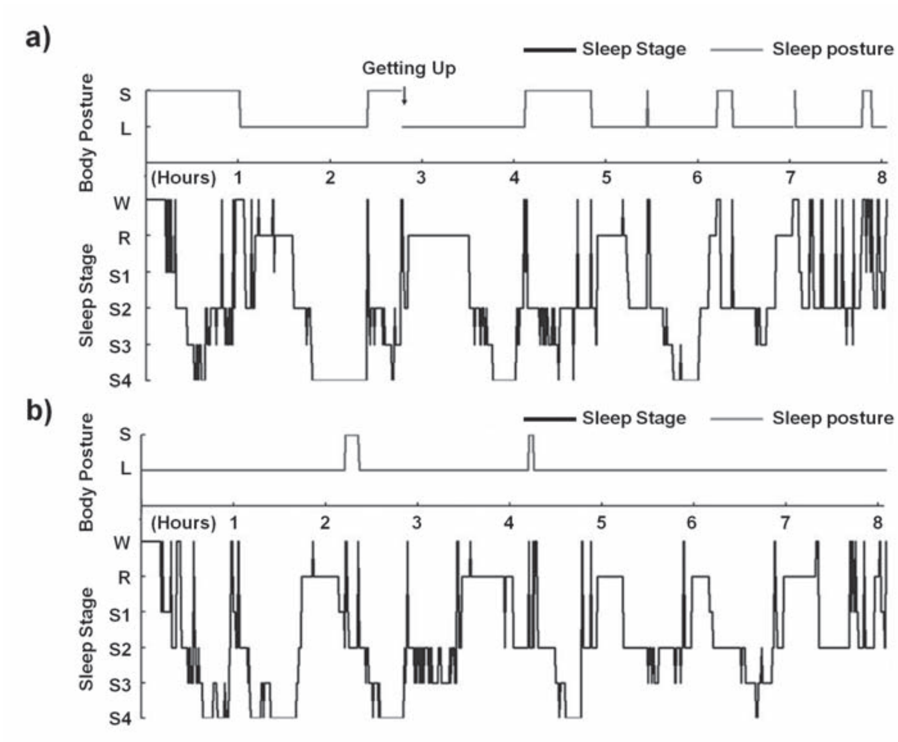

Figure 3. Nocturnal sleep stages and body posture in Free-S and Instruction-S. (a) Free-S: The free postural sleep: the participants slept in their preferred posture. **(b)** Instruction-S: The instructed sleep: the participants were asked to sleep in a lateral position as much as possible. Abbreviations: S, supine; L, lateral; W, awake; R, rapid eye movement; S1-4, stages 1-4, respectively.

Table 3. The rate of sleep stages according to a position in the presence of instructions

Sleep stage[b]	Free[a]			Instruction[a]		
	Supine	Lateral	*p*-value[†]	Supine	Lateral	*p*-value[†]
% Awake	16.5 (9.7)	14.3 (9.4)	0.14	29.2 (19.5)	10.7 (5.9)	0.15
% of Stage 1	7.7 (4.4)	7.8 (4.3)	0.91	10.6 (6.5)	6.8 (5.2)	0.48
% of Stage 2	52.9 (18.7)	46.4 (14.6)	0.17	30.6 (24.3)	46.9 (13.9)	0.36
% of SWS	14.2 (12.8)	13.3 (12.5)	0.18	1.6 (3.7)	19.2 (11.2)	0.03*
% of REM	8.6 (12.1)	18.2 (5.4)	0.08	28.1 (21.0)	16.5 (7.0)	0.36

All values are the means (S.D.). [a] $n = 5$ for each group; [b] Sleep stages except for awake time; [†] paired *t*-test; $*p < 0.05$. SWS, slow wave sleep (stage 3 and 4); REM, rapid eye movement.

Table 4. Evaluation of subjective sleep quality in the presence of instructions

Factor[a]	Free[b]	Instruction[b]	*p*-value[†]
I Sleepiness on rising	19.5 (3.5)	17.3 (4.9)	0.36
II Initiation and maintenance of sleep	21.8 (3.5)	17.0 (5.1)	0.06
III Frequent dreaming	25.5 (5.9)	19.8 (8.4)	0.04
IV Feeling of refreshment	18.3 (4.1)	16.8 (3.1)	0.22
V Sleep length	21.1 (4.9)	20.6 (6.0)	1.00

All values are the mean (S.D.).[a] The Oguri-Shirakawa-Azumi sleep survey sheet (MA edition) are classified under 5 factors (I-V), A higher score indicates a better quality of sleep; [b] $n = 8$ for each group; [†]Wilcoxon signed-rank sum test.

polysomnography results were analyzed also showed the same tendency. The factor of frequent dreaming for Instruction-S was significantly lower than for Free-S (Table 4). In terms of scores in the sleep onset questionnaire, sleep in the Free-S group was 23.5 ± 7.6, while that for Instruction-S was 19.7 ± 5.7, and there were no statistically significant differences between these scores.

The postures for habitual sleep onset and the postures that participants were aware of most frequently during sleep were analyzed according to participants' awareness of postures during sleeping. In total, 4 participants out of 8 reported using the supine position, 3 the lateral posture, and one the supine or lateral posture, in terms of their postures for habitual sleep onset. Meanwhile, 7 participants reported the supine and one reported the lateral posture in terms of their awareness of the most frequent posture while sleeping on the experimental nights when the instructions were not given. One out of 8 participants' awareness differed from the recorded data. In contrast, 7 participants reported the lateral posture and one reported the supine position during the experimental nights when Instruction-S was evaluated. The participants whose awareness differed from recorded data were again one out of 8, and it was the same subject who had differed from the experimental nights when the instructions were not given.

The participants' feedback about what affected their habitual postures during sleeping was analyzed based on voluntary written reasons on the questionnaire. As a result, five out of 8 participants wrote that it was habit and one wrote that it was for the prevention of snoring.

4. Discussion

The major contribution of this study was to clarify that providing instruction on sleep postures could truly affect actual sleep postures, even though the participants were not trained. Moreover, the instructions increased the length of the instructed posture compared to the length of sustained lateral sleep posture without instructions. Furthermore, the instructions did not substantially affect the sleep parameters and the frequency of PCS. Recently, positional therapy, which is designed to minimize supine sleep, has become an important method in the successful management of stroke patients (*24,25*). This result suggested that such instructions represent a simple intervention method for improving sleep posture.

Miki *et al.* disciplined seven male OSA patients' sleep postures prior to their experiments, and gave an instruction about sleep posture on experimental nights (*26*). If patients changed position from the instructed sleep posture, the examiners corrected the sleep posture to the instructed posture without arousal. As a result, they concluded that the lateral position improved the apnea symptoms without inducing any significant difference in sleep parameters (*26*). However, they did not refer to the degree of increase in terms of the instructed posture or the influence on PCS and subjective sleep quality. We were apprehensive about possibly influencing sleep quality by such an intervention. The present study was therefore an intervention that only provides instructions about sleep postures given prior to going to bed, without intervention during sleep. However, the rate of the instructed posture during the experimental night's sleep was significantly increased. The participants' sleep parameters of Free-S in this study were similar to those of healthy men reported in a previous meta-analysis study (*12*). There were no significant differences between Instruction-S and Free-S in terms of the sleep latency, awakening after sleep onset, sleep efficiency, or the rate of the different stages. Furthermore, the rates of SWS for the lateral posture significantly increased compared to the supine position using Instruction-S. Therefore, when the participants were instructed to sleep in the lateral posture, they were still able to move on to deep sleep.

The frequency of PCS in our study correlated within individuals, but there were no statistically significant differences between the frequency of PCS during Instruction-S and Free-S. The rates of SWS in the second half of the total sleep time have been reported to decrease compared to the first half, while the frequency of PCS has been reported to increase with the repetition of a sleep cycle (*3*). Therefore, the postural changes were compared in the first and second halves of the sleep phases. The average frequency of PCS increased in the second half compared to the first half, regardless of whether participants received instructions; however, there were no statistically significant differences. For example, there is the tennis ball technique (TBT), which is a method to put a tennis ball under one's back during sleep, and this helps the patients to maintain a lateral posture (*27*). However, long-term patient compliance with TBT has been suggested to be poor (*28*). As a result, one potential disadvantage of TBT may be related to the fact that PCS is disturbed.

On the other hand, the participants were able to sleep in both lateral sleep postures when instructions were clearly provided in this study, and no disturbance in the participants' postural change was observed. Accordingly, because no difference in the frequency of PCS was observed, the physiological functions of PCS were therefore not suggested to be strongly influenced by the instruction provided in this study.

The subjective sleep quality with Instruction-S showed lower average scores than Free-S in all factors. The factor of 'Frequent dreaming' showed a statistically significant difference. The subjective sleep quality may have been worse in the Instruction-S group. This may have been because the subjects might have been aware of their sleep posture, and underwent a psychological load due to instruction of a posture that they did not like, although this was not proven. Of note, many participants responded that their habits influenced their sleep postures. This may have been related to the reason why 7 out of 8 participants were able to recognize their actual sleep postures, no matter whether instructions were given or not. However, so far, no studies have shown any concrete evidence regarding the mechanism of awareness of humans' sleep posture. In our previous study, correlations were observed between the body positions that participants chose when they fell asleep and in the actual head positions that were observed during sleep, even though there were some individual differentiations (*29*). It suggested that participants would be aware of sleep postures. Although this study could not address the mechanism of the increase in instructed posture, this indicates that the instructions given to participants who sleep in unusual postures affected their subjective sleep quality. We should also be aware of the possibility that a worsening of the subjective sleep quality may occur after participants are given instruction on sleep posture, in particular after the first instruction.

This study has several limitations. First, we only investigated a small number of participants comprising middle-aged and elderly men. Therefore, this study was not able to clarify any effects regarding gender and age differences. This study also did not clarify the mechanism or the long-term effect of instructions on sleep posture, because the experimental term was only 2 nights. In addition, although the participants in this study had an awareness of their habitual snoring during sleep, this study was not able to elucidate any relationship between respiratory function of the participants and sleep quality. However, the results of this study suggest that giving instructions regarding sleep posture could provide a simple, noninvasive, and effective method for improving sleep posture.

Further studies are therefore required to recognize these limitations, and to clarify the mechanism and long-term effectiveness of such instruction on sleep posture, including influence on subjective sleep quality. Furthermore, it is necessary for the instruction of sleep posture to be evaluated in regard to whether it can actually improve respiratory function in obstructive sleep apnea patients.

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