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Research Article

Effects of Positional Therapy on Sleep-Disordered Breathing and Cognitive Function in Community-Dwelling Older Adults

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Abstract

Background: Sleep-disordered breathing (SDB) increases the risk of developing mild cognitive impairment and dementia. Sleeping in the lateral position reduces the number of apnea/hypopnea events and it often improves sleep quality and daytime alertness. We hypothesized that positional therapy for SDB would improve cognitive function in the community-dwelling older adults. The present study examined the effects of positional therapy on cognitive function in this population.

Methods: A total of 34 consecutive volunteers aged 65 years or older (mean age 71.0±3.7 years) participated in the present study. The respiratory event index (REI) and 3% oxygen desaturation index (3%ODI) were evaluated in the supine and lateral position using a home sleep apnea test. Cognitive function was examined using the Wisconsin card sorting test (WCST), number of back task (N-back task), and trail making test (TMT).

Results: The number of participants with REI≥15/h or REI<15/h was 20 (SDB group) or 14 (control group), respectively. The position-dependent REI (a difference of 50% or more in REI between supine and non-supine) was found in 55.0% among SDB group (11/20). The REI and 3%ODI were significantly decreased during positional therapy compared with those at baseline in control group and SDB group. The percentage of corrects answers on the 2-back task and category achievement on the WCST significantly increased and time to completion of the TMT-B was significantly shorter after one month of positional therapy in SDB group. In contrast, there were no significant changes in any of the measured parameters in control group after one month without positional therapy.

Conclusion: Sleeping in the lateral position may be beneficial not only for SDB, but also for cognitive decline. Our findings suggest that treatment of co-existing SDB with positional therapy for one month improves cognitive function in community-dwelling older adults.

Keywords: Sleep-disordered breathing, Positional therapy, Cognitive function, Older adults

Introduction

Sleep-disordered breathing (SDB) leads to hypoxemia and decreased intrathoracic pressure with frequent arousals from sleep, increasing in the risk of cardiovascular diseases [1-4] and automobile accidents [5-6]. Untreated SDB is associated with age-related memory deficits and poor sleep quality, which can further aggravate cognitive decline. The SDB generally increases the risk of mild cognitive impairment or dementia, and it is closely related to the development of hypertension, which is a risk for cognitive decline or dementia [7-8]. Severe SDB has adversely affects cognitive function; however, the relationship between SDB and cognitive function in elderly population remains unknown.

Sleeping in the lateral position reduces the occurrence of apnea/hypopnea events and it often improves sleep quality and daytime alertness. Avoiding the supine position during sleep is a therapeutic alternative for some [9-11], but not for all patients with obstructive sleep apnea (OSA). According to our previous study, the distance between the fauces was the sole morphological difference between the responders and non-responders to the positional therapy for OSA, suggesting that the positional therapy could be recommended for treating OSA with wide fauces [12].

We hypothesized that positional therapy would improve cognitive function in the community-dwelling older adults with SDB. Therefore, we examined the effects of positional therapy on cognitive function in this target population.

Materials and Methods

Study participants

Thirty-four consecutive volunteers aged ≥ 65 years (27 men, 7 women mean age, 71.0±3.7 years), were enrolled in this study as the community-dwelling older adults. None of the participants reported recent declines in memory or cognitive performance, and none had physical impairments in basic or instrumental activities of daily living. The participants taking tranquilizers or hypnotic medications were excluded. The Chubu University Ethics Review Committee approved the study protocol. All participants were informed of the objectives and conditions of the study and provided written informed consent prior to the participating.

Home Sleep Apnea Test (HSAT)

For assessing the severity of SDB at home, we used the portable device (SAS-2100, NIHON KODEN, Tokyo, Japan) of the home sleep apnea test (HSAT) with a nasal pressure sensor for airflow and a pulse oximeter for oxygen saturation (SpO_2). The participants were instructed how to wear and use the equipment. The respiratory event index (REI), minimum SpO_2, and number of oxygen desaturation per hour ≥3% (3% oxygen desaturation index: 3%ODI) were assessed in the supine and lateral position using the device of HSAT. The subjects were classified into two groups of REI≥15/h (SDB group) and REI<15/h (control group).

Positional Therapy for SDB

Positional therapy was performed with one comforter after the baseline SDB and cognitive function analyses in the participants. The participants in the SDB group assigned to receive one month of positional therapy. Cartwright's definition [11] of position-dependent OSA patients required a difference of 50% or more in the number of apnea-hypopnea per hour (responder). The prevalence of position-dependent REI was calculated in SDB group.

Epworth Sleepiness Scale (ESS)

Daytime sleepiness was measured using the Epworth sleepiness scale (ESS), in which the participants rated, on a four-point scale, their chances of dozing in eight possible situations in daily life [13]. The total ESS scores were the sum of all responses, ranging from 0 to 24, and the scores of 11 or greater were regarded to have excessive daytime sleepiness.

Pittsburgh Sleep Quality Index (PSQI)

Subjective sleep quality over the past month was assessed using the PSQI [14]. The PSQI contained 19 items in 7 component domains: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction. The 19 self-rated items were combined to form seven "component" scores, each of which had a range of 0-3 points. In all cases, a score of "0" indicated no difficulty, while a score of "3" indicated severe difficulty. The seven component scores were then added up to yield the PSQI scores, which ranged from 0 to 21, with higher scores indicating worse sleep quality.

Cognitive Performance Tests

We used the revised Hasegawa dementia scale-revised (HDS-R) [15] to identify suspected mild cognitive impairment. We also assessed the three cognitive domains (i.e., executive function, sustained attention, and working memory) using the Wisconsin card sorting test (WCST) [16], number of back task (N-back task) [17,18], and trail making test (TMT) [19]. Those cognitive performance tests were examined between 10:00 to 12:00 in the morning. The data were obtained at baseline and after one month of positional therapy in SDB group, and those were obtained at baseline and after one month without positional therapy in control group.

Hasegawa Dementia Scale-Revised (HDS-R)

The HDS-R was the standard screening test for dementia patients in Japan, similar to the Mini-Mental state examination; both of which showed a high level of correlation [15]. The HDS-R scores below 20 ranging from 0 to 30, were considered indicative of dementia (with sensitivity of 0.9, and specificity of 0.82). The cognitive function was considered normal with the HDS-R scores above 27.

Wisconsin Card Sorting Test (WCST)

The WCST [16] (WCST-KFS version, Japanese Stroke Data Bank, Japan) was used to measure executive functions, such as the abstract reasoning ability and the ability to shift cognitive strategies in response to changing environmental contingencies. A modified computerized version of the WCST was administered, and it was continued until 48 cards were sorted. In this study, performance was measured using the category achievement index.

Number of Back Task (N-Back Task)

The N-back task for measuring the working memory required the participants to update their mental set continually while responding to previously seen stimuli (i.e.,numbers), and the details were described elsewhere [17,18]. The stimulus duration was 0.4 s, the inter-stimulus interval 1.4s with each task comprised 14 trials. The participants responded to the stimuli using the numeric keypad of a computer. The present study used the 2-back conditions, and the performance was measured as the percentage of correct responses (% correct).

Trail Making Test (TMT)

The TMT consisted of 2 parts (A and B) [19] and it provided information on the speed of processing, visual attention, and executive function. Part A required the participants to draw lines as quickly as possible to connect the numbers ascendingly from 1 to 25, when the numbers were appearing in random order on a sheet of paper. Part B required the participants to draw lines to connect the first number with the first letter in alternating pattern to continue connecting the number-letter pairs sequentially as quickly as possible until the last number of 13. Time to completion was recorded for each part of the TMT.

Statistical Analyses

All results are presented as mean ± standard deviation. A value of $p<0.05$ is considered significant. We compared the data of SDB and cognitive function tests, which were obtained before or after one month of positional therapy using the paired t-test. The Pearson's correlation analyses were performed to evaluate the relationships between the severity of SDB, body mass index (BMI), or ESS and the rate of changes by positional therapy. Statistical analyses were performed using the SPSS Statistics version 25.0 (IBM Corporation, Armonk, New York, USA).

Results

Table 1 summarizes the participants' demographics, sleep parameters, and HDS-R score. There were no significant differences in these parameters between the control group and SDB group. The number of participants with REI≥15/h or REI<15/h was 20 (SDB group) or 14 (control group), respectively. Additionally, the prevalence of position-dependent REI (a difference of 50% or more in REI between supine and non-supine) was 55.0% (11/20). No significant differences in REI and 3%ODI were observed between the responder and non-responder groups. The improvement rate in the REI was not significantly correlated with the baseline REI, 3%ODI, BMI, and ESS.

Table 1: Demographics, sleep parameters, and HDS-R score in the control group and SDB group.

	Control group (n=14)	SDB group (n=20)	p-value
Demographics			
Age, years	70.3±3.4	71.4±4.0	0.377
Height, cm	163.0±5.3	159.2±9.2	0.174
Weight, kg	62.2±7.7	64.3±12.0	0.573
BMI, kg/m^2	23.4±2.6	25.3±3.7	0.113
Sleep parameters			
ESS score	5.8±2.5	6.7±3.1	0.348
PSQI score	5.9±3.7	6.4±3.8	0.707
Cognitive function			
HDS-R score	28.5±1.5	27.7±2.2	0.248

Note*: Data are expressed as mean ± standard deviation, SDB sleep-disordered breathing, BMI body mass index, ESS Epworth sleepiness scale, PSQI Pittsburgh sleep quality index, HDS-R Revised Hasegawa's dementia scale.

The REI and 3%ODI were significantly decreased and minimum SpO_2 was significantly increased during positional therapy compared to those at the baseline in the control group and SDB group (Table 2). The percentage of corrects answers on the 2-back task and category achievement on the WCST significantly increased and time to completion of the TMT-B was significantly shorter after positional therapy for one month in SDB group, but there were no significant changes in any of the measured parameters in control group after one month without positional therapy (Table 2).

Table 2: Effects of positional therapy on sleep-disordered breathing and cognitive function.

	Before	After	p-value
Control group (n=14)			
SDB parameters			
REI, /h	7.3±2.3	4.1±2.2	<0.001
3%ODI, /h	11.7 ±3.6	7.1±3.4	0.002
Minimum SpO_2, %	86.6±4.3	89.2 ±2.4	0.048
Cognitive function			
CA on WCST	4.5±0.9	4.9±1.2	0.351
%corrects on 2-back task	56.7±14.0	63.5±22.2	0.109
TMT-B, sec	97.3±18.7	83.2±30.9	0.436
SDB group (n=20)			
SDB parameters			
REI, /h	26.2±10.3	13.0±7.5	<0.001
3%ODI, /h	33.3±10.0	19.6±7.8	<0.001
Minimum SpO_2, %	81.7±5.6	83.5±6.7	0.229
Cognitive function			
CA on WCST	3.9±1.6	4.9±1.3	0.004
%corrects on 2-back task	42.5±16.4	52.2±17.7	0.003
TMT-B, sec	135.5±72.4	103.1±63.8	0.030

Note*: Data are expressed as mean ± standard deviation. SDB sleep-disordered breathing, REI respiratory event index, ODI oxygen desaturation index, CA category achievement, WCST Wisconsin card sorting test, TMT, trail making test.

Discussion

Positional therapy was beneficial not only for SDB, but also for cognitive function in community-dwelling older adults. Our findings suggest that treatment of co-existing SDB using positional therapy can improve cognitive function in geriatric population.

We found that the prevalence of position-dependent REI in older adults was 55.0%, which resulted in improved cognitive decline. According to the previous studies in the patients with OSA by McEvoy, et al. [20] and Neil, et al. [21], the symptoms were ameliorated when the head and trunk of the OSA patients in the lateral position were raised vertically. The tennis ball technique was advocated, wherein the lateral position improved the patients' sleep quality and daytime alertness, and snoring [22]. Moreover, avoiding the supine position by this technique during nighttime sleep lowered the 24-h mean systolic blood pressure in patients with OSA [23]. Given that the prevalence of position-dependent OSA was increased in the elderly population [24], the positional therapy should be considered as a nonpharmacological therapy for SDB in community-dwelling older adults.

In the present study, we showed that the REI and 3%ODI were not associated with the efficacy of positional therapy. Our previous study on the oro-pharyngeal morphology suggested that the responders to the positional therapy could form an oval shaped upper airway with a longer lateral diameter at the level of the oropharynx. In contrast, the non-responders with the shorter lateral diameter could not maintain the oro-pharyngeal patency because of their smaller lateral caliber and their narrow fauces [12]. The prevalence of position-dependent OSA differs depending on the classification system used [24]. The positional therapy induces complex changes in the shape and function of the upper airway during natural sleep [25] and these changes might influence the ability of such therapy to reduce SDB.

Although the clinical significance and mechanisms underlying the effects of positional therapy should be assessed in a larger geriatric population with SDB in the future, the reduced incidence of SDB improved cognitive function in older adults with SDB. To the best of our knowledge, it is the first findings comparing the SDB group to non-SDB group in the effect of positional therapy on cognitive function. Assessment of the effect of positional therapy for one month can be clinically important after the initial evaluation of SDB and cognitive function but long-term follow-up of individuals with SDB is warranted.

Conclusion

The SDB reduced by the lateral sleeping position, resulting in an improvement in cognitive function. Positional therapy should be considered as a nonpharmacological adjunct in community-dwelling older adults with SDB.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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