Changes in the sleep during prolonged bed rest in healthy young men

Reiko Sato, MA
Oita University of Nursing and Health Sciences

Jukai Maeda, MS
Nagano College of Nursing

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Abstract

The sleep of four healthy young adult men was studied during a period of 20 days under bed rest conditions. The electroencephalograms (EEGs) were recorded during three 24-hour sessions (started from 21:00 to the subsequent day 21:00) on the 1st, 10th and 20th days of the bed rest period. Significant differences were found among the three measurement sessions in time length in stage II sleep, in rapid eye movement (REM) sleep and in total sleep. No differences were found in time length in stage I sleep, stage III + IV sleep and sleep latency. These results suggest that the sleep in healthy young adult men changed during the 20 days of bed rest.

Key words
sleep, electroencephalogram, bed rest, young adults

1. Introduction

It is important for nurses to understand the sleep of patients who are in bed for a long time. According to previous studies, bed rest or physical immobilization conditions among healthy young adults can lead to physiological function changes. Deitrick et al. (1948) studied various metabolic and physiologic functions of normal healthy men who underwent a course of six to seven weeks of immobilization. The participants were placed in bi-valved plaster casts extending from the umbilicus to the toes. Their basal metabolic decline rates during the course of immobilization averaged 6.9 percent. Several investigators studied the effects of continuous bed rest (head-down, tilted six degrees) on the physiological functions of healthy young adults (DeRoshia and Greenleaf 1993, Samel et al. 1993, Monk et al. 1997). A decrease of circadian amplitude of heart rate rhythm was observed during the first 7 days of the bed rest period (Samel et al. 1993). Psychomotor performance test score did not decline in response to 30 days of bed rest (DeRoshia and Greenleaf 1993). Sleep onset latency increased during 17 days of bed rest (Monk et al. 1997). Other investigators studied the effects of 20 days of horizontal bed rest on human psycho-physiological functions (Haruna et al. 1994, Ishizaki et al. 1994). Basal oxygen uptake decreased during the first 10 days of bed rest (Haruna et al. 1994). Psychological effects, such as mental stress, escalated after bed rest (Ishizaki et al. 1994). The total sleep time of healthy young adults did not significantly increase during the 7 days of bed rest (Ohta 1983).

However, the bed rest condition of these sleep studies was incomplete and the experimental period was relatively short. Before examining the effects of prolonged bed rest on the patients, we examined the similar effects in healthy adults. The present study was undertaken to explore the effects of prolonged (more than 20 days) horizontal bed rest on sleep in healthy young adults, based on electroencephalogram (EEG).

2. Subjects and Methods

Participants in this study were four healthy adult male students at a co-medical school of hygienics, aged between 19 and 25. They gave their written consent after a thorough explanation and discussion of the study procedures. The study design and protocol were approved by the Institutional Review Board (Human Subjects Ethics Committee), School of Medicine, University of Tokyo, Japan.

(1) Bed Rest Conditions

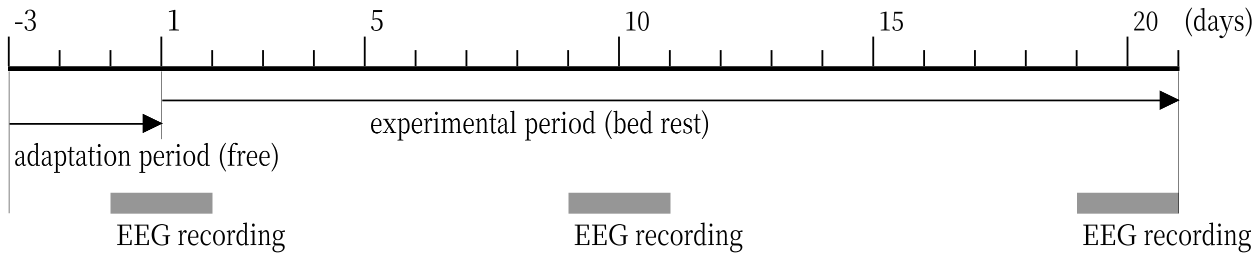

Fig1. Outline of the present study

The data collection was initiated following three adaptation nights at a medical unit of a university-affiliated hospital (Figure 1). During the 20-day bed rest study, the participants were physically restricted to a horizontal supine position within a bedroom in the study unit. The bedrooms were air-conditioned, and the room temperature was kept between 25 °C and 28 °C at all times. The room light was turned off at 22:00. The participants were allowed to watch television or videotapes, listen to audiotapes or radio, or read books or magazines. They received standard hospital meals three times a day at 7:00, 12:00 and 18:00, and had no strict restrictions against eating snacks or smoking. They were also allowed to see visitors. However, they were restricted to a minimum of physical activities and were not permitted to leave their beds. They were transferred into a wheelchair to go to the bathroom or for personal hygiene. They were not permitted to stand or sit up at all; instead, each participant was allowed to elevate his upper body on its side while eating or reading.

(2) EEG Recording

EEG data were recorded from C3 and C4 with reference to A1 or A2. The electromyogram and electrooculogram were also recorded using standard methods. Signals were amplified and monitored with an ambulatory EEG polygraphy recorder (6R21, NEC-SANEI., Japan) and were recorded onto magnetic tapes using a compact cassette data recorder (HR40I, TEAC., Japan). Each recording was printed onto an EEG recording paper for a subsequent visual scoring with 60-second epochs using standard criteria (Rechtschaffen and Kales 1968). Each 60-second epoch was scored as stage I sleep, stage II sleep, stage III sleep, stage IV sleep, rapid eye movement (REM) sleep or wakefulness. EEGs were recorded at the 1st, 10th, and 20th days of bed rest. Each measurement session started at 21:00 and lasted for 48 hours. The EEGs for the latter half of 48 hours were analyzed (Figure 1). The length between 22:00 and the onset of the two consecutive minutes of stage I was defined as sleep latency.

(3) Data Analysis

Because the data were not normally distributed, Friedman tests were used for statistical analysis.

3. Results

The observed sleep time is summarized in Table 1. Significant differences were found among the three measurement sessions in time length in stage II sleep (p=0.0388), REM sleep (p=0.0388) and total sleep (p=0.0388). No differences were found in time length in stage I sleep, stage III

Table 1. The mean values and standard deviations (SD) of the 6 sleep parameters during the measurement sessions of the 1st, 10th, and 20th days of bed rest.

Sleep parameters (min)	1st day		10th day		20th day	
	mean	SD	mean	SD	mean	SD
Sleep latency	144.9	34.7	274.6	66.9	259.3	137.7
Total sleep time*	388.2	16.7	439.8	33.4	354.8	76.7
Stage I	65.6	30.9	38.7	23.9	53.5	23.3
Stage II*	174.9	19.6	217.2	13.5	158.1	59.7
Stage III＋IV	60.8	10.6	60.7	28.2	62.9	14.8
Stage REM*	86.8	18.3	125.0	21.9	80.5	34.4

number of participants=4, *: p=0.0388

+ IV sleep and sleep latency.

4. Discussion

Monk et al. (1997) reported that sleep onset latencies increased during 17 days of bed rest. The total sleep time showed no significant increase during 7 days of bed rest (Ohta 1983). The results of the present study, however, showed that total sleep time significantly changed during 20 days of bed rest. These inconsistent results are probably attributed to the differences of bed rest conditions in these studies. The participants in the study of Monk et al. (1997) were restricted to a supine position (head-down, tilted six degrees) for 17 consecutive days and were strongly encouraged to sleep between 23:00 and 7:00. Ohta (1983) instructed the participants to take bed rest for 19.5 hours daily during a 7-day period; the day-night cycles and dietary schedules were fixed. In the present study, the participants were restricted to a horizontal position all of the time for 20 days, but were not forced to sleep.

According to Monk et al. (1997) the variations of the sleep onset latencies during the bed rest periods are due to the reduced amplitude of body temperature circadian rhythms and the delay of sleep phases resulting from the bed rest conditions. The mechanism underlying the phenomenon in our results, however, is still unclear, since other physiological functions associated with sleep changes and bed rest have not been examined. Under the same bed rest conditions that we adopted in this study, several investigators studied the effects of bed rest on physiological functions (Haruna et al. 1994, Ishizaki et al. 1994). In the study of basal metabolism changes during 20 days of bed rest, Haruna et al. (1994) reported that basal oxygen uptake significantly decreased during the first 10 days of bed rest and leveled off during the following 10 days and that body temperature did not change significantly. Using psychosomatic stress indices, Ishizaki et al. (1994) reported that the degree of the participants' mental stress was influenced by their bed rest conditions. In the rat subjected to chronic stress, Kant et al. (1995) reported that sleep decreased in the light hours and increased in the dark hours. We hypothesize that sleep changes found in the present study can be related to a decrease in basal metabolism and an increase in mental stress during the bed rest conditions.

As shown above, the effect of prolonged bed rest on total sleep time of healthy adults was not simple. Further studies are warranted in order to investigate comprehensive physiological mechanisms of sleep changes and perceived stress with a variety of age and different gender groups.

Acknowledgments

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Author for correspondence

Department of Adult and Gerontological Nursing
Oita University of Nursing and Health Sciences
2944-9, Megusuno, Notsuharu, Oita 870-1201, Japan
Reiko Sato
sator@oita-nhs.ac.jp