POLYGRAPHIC FINDINGS IN CONDITIONS OF SIMULATED MICROGRAVITY

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Summary

The sleep of ten healthy male volunteers aged between 26 and 35 years (mean age 29.4 years) staying in a normal anti-bed-sore bed for a three day period always in supine position and after a four day interval spending another three day period in a simulated microgravity condition, was polygraphically recorded. A comparison between the values obtained in bed and in simulated microgravity conditions was performed by means of Student's t test for small values. All the data were also compared to those of a control group of ten male subjects matched for age. A statistical significance between the values regarding the three nights in bed and the values regarding the three nights in simulated microgravity was found for the following parameters: total stage 1, night III; total stage 2, night I; total REM, nights I and II; REM latency, nights I and III; stage 1 latency, night III; spindling index, night III.

Key words: sleep - simulated microgravity

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Introduction

The effects of microgravity in man might represent a new field of

research with many aspects still to be defined (1,2).

Studies on this topic in fact are still lacking. Therefore this study on 10 healthy male volunteers may be considered as a preliminary report of much more wide-ranging investigation dealing with a greater number of subjects and a longer period of observation.

Materials and methods

Ten healthy male volunteers aged between 26 and 35 years (mean age 29.4 years) were polygraphically recorded in conditions of simulated microgravity.

The volunteers stayed in a normal anti-bed-sore bed with a 10 by 10 cm cubes foam mattress for a three day period, always in supine position. After a four day interval they spent another three day period in a simulated microgravity condition. The pool used for this purpose was circular with a 3.5 meter diameter and one meter depth, resting on the floor and separated by an appropriate insulating material.

The pool was always full of water which was continuosly changed by a pump and mantained at the costant temperature of 31°C by a thermostat.

A 0.5 mm-thick plastic sheet was placed above water level. The subjects were separated from the plastic sheet by a cotton sheet.

Polygraphic recordings were performed by means of a Vega 10 polygraph according to Rechtshaffen and Kales criteria (3).

The recording protocol consisted of:

a) three nights'monitoring in bed;

b) three nights'monitoring in simulated microgravity.

The start and end of the polygraphic recordings were based on light-off and light-on times.

Two volunteers were immersed in the pool at the same time to avoid the occurrence of psychological problems related to the adaptation.

During daytime the volunteers were allowed to enjoy various recreative activities (reading books, watching movies, etc). Some of them assumed treatment to relieve the back pain usually related to the experimental conditions.

The sleep scoring was performed according to Rechtshaffen and Kales criteria (3).

The following parameters were taken into consideration: total time in bed (TTIB), total sleep time (TST), latency times to sleep stages 1, 2, 3, 4 and REM, percentages of time spent in different sleep stages, spindling

index and rate according to Angeleri el al. (1990) (4).

A comparison between the values obtained during each night in the continuous in bed recordings and those obtained for each night in the simulated microgravity condition was performed by means of Student's t test for small values. The values were significative if were out the theoric value of T included, in a two code test at a significans level of 0.05 with N1 + N2 - 2 free grades, between - 2.10 and + 2,10.

All the data were also compared to those of a control group of ten male subjects matched for age.

Results

The results are shown in details in tables I and II.

TTIB both in physiological conditions and in simulated microgravity pool was calculated from light-off to light-on time. In both conditions TTIB as well as TST, WASO and percentages of the various sleep stages displayed several changes across the nights with a great interindividual variability. REM stage showed the greatest variability, both as far as latency and percentage.

All stages of sleep were always recorded during the bed condition, as well as in the pool with the exception of two subjects who only displayed during the first night, stage 1 and 2.

Rebound phenomena were also observed in relation to sleep spent in the different stages across the nights, especially stages 4 and REM.

Spindling rate and index increased with increasing of sleep stage across the nights; the only change in spindling was in fact related to its percentage. No significant variations of eye movements were observed in either REM or NREM sleep.

A statistical significance between the values regarding the three nights in bed and the values regarding the three nights in simulated microgravity was found for the following parameters:

- total stage 1, night III;
- total stage 2, night I;
- total REM, nights I and II;
- REM latency, nights I and III;
- stage 1 latency, , night III;
- spindling index, night III.

Discussion

To maintain a continuous supine position for a three day period is a sufficient condition to alter the regularity of sleep, regardless of the normal adapting period. In fact no restoration of normal sleep pattern was observed on the third day.

Sleep disruption might be due not only to the back pain since in the three day period spent in bed pain was less disabling that during the three day period in the pool, where it was controlled by pain-killers.

Supine position per se was not responsible probably for sleep disruption, since in the pool the latter was considerably increased in comparison with the bed period.

A continued supine position may alter the regularity of sleep by different mechanisms:

a) It could be related to the occurrence of several "microsleeps", changing the regularity of the main sleep period; however even if this hypothesis cannot be excluded it is unlikely the only explanation since only 4 volunteers were observed to doze off occasionally, while sleep disruption was otherwise widespread in our sample.

b) The continued and painful supine position could represent a stressful experience disrupting itself the regularity of sleep; this could in part explain a greater variability in REM sleep.

c) Electrophysiological tests carried out during day-time, although interspersed with regular pauses, could constitute a stressfull event.

On the other hand simulated microgravity could worsen sleep in relation to the following factors:

a) A reduced sensory input, especially the proprioceptive one, occurring in simulated microgravity, could, by a central mechanism, alter the regular occurrence of the sleep-waking rhythm.

b) The simulated microgravity could be a more stressful condition than the continuous supine position in bed; the basic mechanism of such stress could be direct or caused by a mild transitory alteration of the body scheme perception.

A greater number of volunteers and a longer period in simulated microgravity will be necessary to better define the mechanisms responsible for sleep disruption in the condition of simulated microgravity.

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Table I: Mean values of sleep parameters

	NIGHTS IN BED			IN MICROGRAVITY		
	I	II	III	I	II	III
TST*	451	421	428	363	435	452
WASO*	23.30	50.90	42.20	108.8	28.70	29.90
Stage 1*	11.80	16.86	8.85	19.07	10.68	16.58
Stage 2*	38.18	36.25	35.95	28.00	27.39	34.26
Stage 3*	8.32	6.43	7.81	6.23	6.07	7.35
Stage 4*	14.72	12.89	17.40	11.80	14.40	15.49
NREM*	73.02	72.43	70.01	65.10	58.24	73.68
REM*	20.51	14.24	18.74	12.50	32.26	20.87
REM latency*	100	109	90	66	123	77
Stage 1 latency*	5	5	6	5	13	3
Stage 2 latency*	21	30	24	51	31	25
Stage 3 latency*	32	46	38	22	37	32
Stage 4 latency*	56	64	53	46	62	50
Spindling rate(/min)	6.5	5.8	5.9	5.6	4.9	5.3
Spindling index	19.0	16.3	20.0	16.3	14.1	15.4

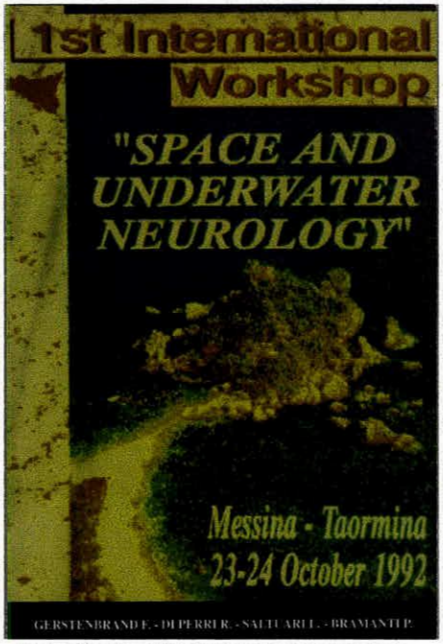
*in min

Table II: Student's t test values

	NIGHT I	NIGHT II	NIGHT III
TST	1.98	-0.57	-0.87
WASO	-1.96	0.69	1.60
Total stage 1	-1.79*	1.77	-2.99*
Total stage 2	2.60	-0.02	0.65
Total stage 3	0.67	-1.40	0.83
Total stage 4	1.40	-0.98	2.01
Total NREM	0.94	0.75	-1.49
Total REM	3.56*	-2.25*	-0.49
REM latency	2.50*	-0.63	2.41*
Stage 1 latency	-0.73	-1.80	2.26*
Stage 2 latency	-1.93	-0.38	-0.40
Stage 3 latency	-0.29	0.57	0.74
Stage 4 latency	0.38	0.06	0.38
Spindling rate	1.20	0.94	1.72
Spindling index	1.42	1.50	3.08*

* Significant values

SUMMARY



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