A New Method of Sleep Staging Based on a Reduced Montage Using 2 EOG channels

Gruber G [1], Dorffner G [1,2], Parapatics S [1]

[1:] The Siesta Group, Vienna, Austria

[2:] Medical University of Vienna, Section for Artificial Intelligence and Decision Support, Vienna, Austria

OBJECTIVES

Currently, objective assessment of sleep architecture and sleep continuity in clinical trials relies on the recording of distinct biological signals (at least electroencephalography - EEG, electrooculography – EOG, and electromyography - EMG) for a full night.

This method – polysomnography (PSG) - is usually performed at specialized sleep-labs requiring skilled personnel and full equipment, and – being expensive and to some extent burdensome for the patient - limits the number measurements to only a few nights in a protocol.

However, this might not be representative for a patient's sleep. Thus, a portable, less intrusive and self-applicable solution for sleep measurement would allow for the acquisition of more nights in the patient's familiar environment.

AIMS

The aim of this paper is to investigate if a reduced setting, requiring 2 EOG channels only will yield comparable results to a full PSG including 6 EEG, 2 EOG, and 1 EMG channel.

DESIGN

Sleep recordings from 36 healthy controls (2 nights each) were analyzed using a validated computer assisted scoring system (Anderer et al. 2010).

Only the standard 2 EOG channels were used as input data, which were submitted to a modified version of the analyzer.

As a proof of concept, the reduced montage was applied to analyze the first night effect (FNE) in comparison to the full montage.

RESULTS

The main 3 states wakefulness (r=0.87), NREM sleep (r=0.77) and REM sleep (r=0.68) were identified effectively (full montage versus reduced montage, see Fig. 1).

On an epoch-by-epoch basis, Cohens Kappa was 0.65 ("good agreement) with agreement rates of 86% for W, 81% for SWS, and 84% for REM, respectively (Table 1).

When comparing the effects of adaptation (FNE), the reduced montage revealed a similar pattern of results as the full montage (Table 2).

	W	N1	N2	N3	R
W	**85.9**	9.5	1.7	0.7	2.1
N1	1. 13. 6	**51.6**	21.2	1.1	12. 6
N2	3.7	15.5	**66.1**	5.0	9.7
N3	0.3	0.6	17.9	**80.6**	0.7
R	5.1	7.1	3.6	0.1	**84. 0**

Table 1: Confusion matrix of sleep stages (full vs. reduced montage)

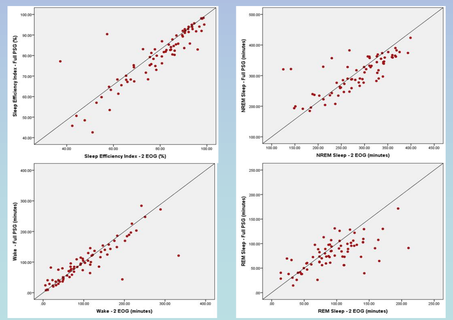

Fig 1: Sleep Efficiency, Total Wake Time, NREM and REM sleep duration (full vs. reduced montage)

Target Variable	2-tailed Significance	
	Full PSG	Reduced PSG
Sleep Efficiency Index	.007	.009
Total Sleep Time	.019	.011
Total Sleep Period	.001	.001
Wake within TSP	.021	.077
Wake after Final Awakening	.882	.779
Latency of Continuous Sleep	.015	.007
REM Latency	.002	.008
Stage N1 (minutes)	.972	.456
Stage N2 (minutes)	.138	.498
Stage N3 (minutes)	.028	.002
Stage R (minutes)	.001	.006

Table 2: Significant differences between first and second PSG nights (paired t-tests)

CONCLUSION

This work provides promising evidence that, with the proper modification of existing computer-based sleep scoring solutions, a reduced montage permits sleep measurements that lead to results comparable to full PSG, at least with respect to many important sleep variables.

At least in a cross-over design, the results obtained with a reduced montage are similar to the ones obtained with a full montage.

Anderer P, Moreau A, Woertz M, Ross M, Gruber G, Parapatics S, Loretz E, Heller E, Schmidt A, Boeck M, Moser D, Kloesch G, Saletu B, Saletu-Zyhlarz GM, Danker-Hopfe H, Zeitlhofer J, Dorffner G. Computer-assisted sleep classification according to the standard of the American Academy of Sleep Medicine: validation study of the AASM version of the Somnolyzer 24 × 7. Neuropsychobiology. 2010;62(4):250-64.

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Contact: georg.gruber@thesiestagroup.com

www.thesiestagroup.com