ELSEVIER

Sleep Medicine 8 (2007) 484–490

SLEEP MEDICINE

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Original article

The influence of different definition criteria on the PLM index

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Received 3 May 2006; received in revised form 29 June 2006; accepted 30 June 2006
Available online 17 January 2007

Abstract

Background: Different criteria for the scoring of periodic leg movements (PLM) have been recently proposed. We investigated to what extent changes in PLM criteria for leg movement duration, intermovement interval and combination of bilateral leg movements (LM) influence the PLM index.

Methods: The nocturnal polysomnographies of 40 consecutive patients (20 males, 20 females, mean age 52 ± 16 years) with sleep-wake complaints but without severe sleep-related breathing disorders (AHI < 20) were evaluated. All patients showed a minimum of 100 LMs during the night. For each night eight PLM indices during sleep (PLMS) and eight PLM indices during wakefulness (PLMW) were computed by systematically varying the following criteria: LM duration (0.5–5 s vs. 0.5–10 s), intermovement interval (5–90 s vs. 10–90 s), and separation criteria for LMs occurring in both legs (<5 s onset to onset vs. <0.5 s offset to onset). Data were analyzed using linear mixed models.

Results: The two different intermovement intervals and the leg movement durations both had a statistically sifnificant influence on the PLMS and PLMN indices. These variations were highly systematic but numerically small for the PLMS index while they were substantially larger for the PLMW index. The seperation criteria or possible two-way interactions between the criteria had no influence on the PLM indices.

Conclusions: Different criteria had a negligible influence on the PLM index during sleep. Across-study or sleep-laboratory comparability can be assumed within our parameter set. This does not apply to the PLM index during wakefulness.
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Keywords: Periodic leg movements; Leg movements; Scoring criteria; Intermovement interval

1. Introduction

Periodic leg movements (PLM) are among the most frequent observable events in the sleep laboratory. They are especially prominent in patients with restless legs syndrome (RLS) [1,2], but they are also found in a large proportion of subjects with Parkinson's disease [3], REM sleep behavior disorder [4,5], or narcolepsy [6,7], and can be present in obstructive sleep apnea [8,9], insomnia [10] and hypersomnia [11,12].

The definition and scoring of PLM were formally defined by the American Sleep Disorders Association (ASDA) Task Force in 1993 [13] based on the work of Coleman in 1982 [14]. This year, new standards for recording and scoring periodic leg movements were proposed by the World Association of Sleep Medicine (WASM) in collaboration with a task force from the International Restless Legs Syndrome Study Group (IRLSSG) [15]. One concern expressed was that "even small changes in the criteria of detection of the single PLM may have a significant impact on the final results of the analysis by attering the range of PLM included. This could significantly modify the numerous characteristics derived from analyses of the PLM" and "changes in the classification criteria of events, inter-movement

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doi:10.1016/j.sleep.2006.06.013

intervals and periodicity can influence significantly the indexes related to PLM, thereby impacting the evaluation of sleep disorders" (p. 175) [15].

The present study was designed to evaluate changes in the PLMS and PLMW index in light of different definitions of key scoring criteria, namely the intermovement interval, leg movement (LM) duration and criteria to separate bilateral LMs.

2. Methods

2.1. Subjects

We prospectively included 40 consecutive patients with sleep-wake complaints and a full overnight polysomnography and a minimum of 100 leg movements (0.5–10 s) during the night. Patients with an apnea-hypopnea index above 20 were excluded. Written informed consent was obtained from all subjects. None of the subjects were treated with hypnotic or dopaminergic medication, but those with a psychiatric diagnosis (see Table 1) took various psychopharmacological drugs according to therapeutic needs.

2.2. Polysomnography

The polysomnographic recordings included right and left electro-oculograms (EOGs), two electroencephalography (EEG) channels (C3-A2, C4-A1), and three electromyogram (EMG) channels (chin muscle region and tibialis anterior muscle of the right and left leg). Electrode placement for the EMG of the legs followed standard guidelines [13]. In all patients oronasal air flow, thoracic and abdominal breathing efforts and oximetry were performed. Sleep recordings were visually analyzed by experienced scorers according to Rechtschaffen and Kales [16]. Data were recorded using a digital sleep-recording system (Schwarzer Brainlab 3.30, Munich, Germany) at a sampling frequency of 250 Hz and a sensitivity of 50 μV. The EMG amplitude resolution exceeded 0.01 μV. High-pass and low-pass filters were set at 16 and 300 Hz, respectively.

2.3. Leg movement detection and computation of PLM indices

Leg movements with a duration of 0.5–10 s were detected with a validated automatic detection algorithm [17]. A detailed file including the beginning and end of each LM (in milliseconds), the side of the LM (left/right) and scored sleep stage were exported for each night. These data files were imported into R [18] and a programmed function marked individual leg movements as PLM according to the different criteria applied:

- *LM duration*: Two different durations were considered: (i) 0.5–5 s, and (ii) 0.5–10 s;
- *Separation criteria*: Temporally close LMs in the right and left leg were considered as simultaneous LMs and counted as one LM when the onset between both

Table 1
Study sample description

Group	*N*	Age	Female:male	Other sleep disorders (*n*)[a]	Psychiatric disorders (*n*)[a]
RLS	17	57 ± 16 (22–91)	11:6	None (5) OSAS with nCPAP (2) Mild OSAS (4) Snoring (3) CAHS (1) Idiopathic hypersomnia (1)	None (9) Affective disorder (8) Anxiety disorder (1)
PLMD	7	45 ± 18 (31–68)	4:3	None (1) Narcolepsy (1) Rhythmic movement disorder (1) Sleep bruxism (1) Mild OSAS (2) Snoring (1)	None (3) Affective disorder (2) Personality disorder (1) Psychotic disorder (1) Eating disorder (1)
Mixed	16	48 ± 14 (19–67)	5:11	None (6) Insufficient sleep syndrome (2) Shift work sleep disorder (1) Inadequate sleep hygiene (1) Nightmares (1) Snoring (4) Mild OSAS (4) REM-sleep without atonia (2)	None (5) Affective disorder (8) Anxiety disorder (1) Psychotic disorder (1) Dementia (1) Chronic fatigue syndrome (1)

RLS, restless legs syndrome; PLMD, periodic limb movement disorder; OSAS, obstructive sleep apnea syndrome; CAHS, central alveolar hypoventilation syndrome.

[a] Multiple disorders for same subject possible.

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