Conclusion: The OSA and PLMS patient exhibited an increased sympathetic activity and decreased parasympathetic activity, implying a possible additive effect of OSA and PLMS on HRV.
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INTRACEREBRAL SOURCES OF PERIODIC LEG MOVEMENT DURING SLEEP

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Introduction: Periodic leg movements during sleep (PLMS) are repetitive and involuntary jerking movements of the legs during sleep. PLMS are observed in many patients with sleep disorders including restless legs syndrome (RLS). Decreased dopamine transmission associated with neuronal hyper-excitability of the central pattern generator has been suggested as the pathophysiology of PLMS. However, its localization and the origin of rhythmicity remains uncertain. Here, we investigated the intracerebral sources of PLMS using electroencephalographic (EEG) spectral power analysis, and for the first time showed the correlation between rhythmicity of PLMS and intracerebral source.
Methods: Polysomnography data of 14 patients with RLS were included in the present study. Electromyographic, 19-channel EEG with 10–20 system, and electrocardiographic (ECG) signals were obtained. To investigate PLMS-related neural synchronies, delta-band (2–4 Hz) and alpha-band (8–12 Hz) activities were analyzed. Spectral power for EEG channels was obtained and topography or average values were measured. The data were analyzed compared to the values of baseline interval which was set to -15 to -10 seconds preceding to the leg movement (LM) onset. Source localization was done using the head model in FreeSurfer toolbox and Beamformer method to solve inverse problems. Correlation between PLMS rhythmicity (PLMS index or inter-movement interval (IMI)) and intracerebral sources were tested.
Results: EEG and ECG signals began to change at 3–4 second ahead of LM onset. Especially, delta-band was the first signal to increase, and was immediately followed by ECG and alpha-band signals. Before the LM onset, the source of delta-band was localized into right precentral gyrus between -3 and -2 second. Just after LM onset, the source was at bilateral superior frontal gyri. During -5 and -2 seconds, PLMS index was correlated with delta power in left anterior cingulate gyrus, and IMI was negatively correlated with both left anterior cingulate gyrus and right inferior parietal gyrus.
Conclusion: Intracerebral sources of PLMS differed temporally according to the EEG signals. Rhythmicity of PLMS was well correlated with electrophysiological spectral power in cingulate gyrus. Our data provide insight into a cortical organizing mechanism of PLMS.
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PERIODIC LEG MOVEMENTS IN SLEEP PERSISTING AFTER TREATMENT WITH POSITIVE AIRWAY PRESSURE DESERVE ATTENTION FOR INCREASED CARDIOVASCULAR RISK

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Introduction: Obstructive sleep apnea syndrome (OSAS) and periodic leg movements in sleep (PLMS) are amongst the most common sleep disorders and usually exist together. The effects of positive airway pressure (PAP) treatment of OSAS on PLMS have not yet been clearly demonstrated. Here we investigated the determinants of the fade of PLMS following PAP therapy.
Methods: Consecutive 300 patients diagnosed with OSAS by full-night polysomnography (PSG) were evaluated. Clinical and PSG data were recorded in detail into SPSS 24.0 program and comparisons between parameters were calculated using appropriate statistics.
Results: Of patients with OSAS, 68% were males; mean age of the study group was 54.2 ± 10.6 years ranging between 25–75 years. The mean body mass index was calculated as 30.9 ± 5.1 kg/m^2. In comparison of diagnostic PSG, mean durations of N3 and R sleep were increased significantly in PAP titration night showing effective treatment. At diagnostic PSG, 43.7% had a PLMS index of ≥15 per hour (with a mean of 41.9 ± 30.2/hr), and 37% had an index of ≥15/hr at titration PSG (with a mean of 47.9 ± 31.6/hr). Analysis of the determinants of persisting PLMS at titration night revealed that respiratory disturbance index, body mass index and ferritin levels did not show a significant correlation; nevertheless, the mean age of patients (p=0.003) and PLMS index at diagnostic PSG (p=0.001) showed a positive correlation. In patients with a PLMS index ≥15/hr at titration night, Willis/Ekbom disease was significantly more common (36.6% vs 25%, p=0.025). Moreover, hypertension (p=0.006) and cardiac diseases including myocardial infarction and heart failure (p=0.040) were also more common in these patients.
Conclusion: Although PAP titration is a very effective treatment for OSAS, it doesnot show a beneficial effect on PLMS. Because PLMS is commonly associated with OSAS, it should be carefully examined in polysomnographic studies. Because both of these disorders are associated with an increased risk of cardiovascular disease, persisting PLMS may be responsible from new cardiovascular events in OSAS patients even though they were effectively-treated with PAP therapy.
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PREVALENCE AND CLINICAL AND POLYSOMNOGRAPHIC VARIABLES ASSOCIATED WITH PERIODIC LIMB MOVEMENTS IN SLEEP (PLMS) IN PATIENTS WITH OSA

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Introduction: We aimed to assess the prevalence and clinical and polysomnographic variables associated with PLMS in patients with OSA in Apnea Positive Pressure Long-term Efficacy Study (APPLES), a prospective 6-month multicenter randomized controlled trial with 1105 subjects with OSA.

Methods: All participants underwent a polysomnogram (PSG). The apnea hypopnea index (AHI), total sleep time (TST), Sleep Efficiency (SE), Sleep Onset Latency (SOL), arousals and PLM Index (PLMI) were computed.
Results: Of all subjects, 19.7% of the participants had PLMI ≥ 10/hour, 14.8% had PLMI ≥ 15/hour, 12.1% had PLMI ≥ 20/hour and 7.5% had PLMI ≥ 30/hour. The 75th percentile PLMI was 5.5, 80th percentile was 9.3, 90th percentile was 24.1 and 95th percentile was 37.2/hour. PLMI was associated positively with SOL (R=.075, P=0.01) and inversely with SE (R=-.113, P=<0.001) and TST (R=-.106, P=<0.001). Linear regression models showed that the association between PLMI and sleep variables was independent of AHI and depression (HAMD score). There was no significant correlation between PLMI and AHI, Epworth Sleepiness Scale scores or Maintenance of Wakefulness Test sleep latency. No correlation was seen between PLMI and Hamilton Depression Rating Scale (HAMD) or Sleep Apnea Quality of Life Index (SAQLI) scores. A linear regression model showed increasing age (Beta=.19, P<0.01) and total caffeine servings per week (Beta=.09, P=0.02) to be independent predictors of PLMI. A logistic regression model showed higher odds of PLMI ≥ 10 with older age (OR=1.03, P<0.001), male gender (OR=1.63, P=0.01), antidepressant use (OR=1.48, P=0.048), and caffeine servings per week (OR=1.01, P=0.04). In comparison with those with PLMI<10, those with PLMI ≥ 10 had lower AHI (37.3 ± 20.6 vs 40.7 ± 26.2, P=0.04), lower SE (75.8 ± 13.2% vs 78.8 ± 12.5%, P=0.02) and TST (364.6 ± 66.9 vs 379.3 ± 64.7 minutes, P=0.003), higher arousal index (32.2 ± 20.6 vs 28.7 ± 20.4/hour, P=0.03) and a tendency towards higher SOL (21.8 ± 25.9 vs 18.3 ± 20.9 minutes, P=0.06).
Conclusion: This study confirms a high prevalence of PLMS in patients with OSA. PLMI was associated with worse sleep quality but not excessive daytime sleepiness.
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PILOT STUDY OF PERIODIC LEG MOVEMENT CLASSIFICATION WITH LEG-WORN ACTIGRAPHY

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Introduction: Chronic pain may be accompanied by periodic leg movements (PLM) during sleep. The goal of this study was to validate the capability of Quell® (NeuroMetrix, Inc.), a transcutaneous electrical nerve stimulation device with built-in actigraphy that is worn on the calf for the treatment of chronic pain, to classify patients with an abnormal PLM index. Polysomnography (PSG) was used as a gold standard.
Methods: Patients referred to the Massachusetts General Hospital Sleep Center were eligible for the study. Inclusion criteria were: age 18–75 years and expected wake time < 30% of total sleep time. Ten subjects were recruited, half wearing one device, and the other half wearing one device on each leg which analyzed PLM independently. PSG data were collected following clinical standards and scored by the same technician. PLM were scored during sleep and wake, and across respiratory events, using bilateral surface EMG. Patients were grouped as abnormal if their PLM Index (PLMI) > 15. The actigraphy device detected leg movements with 0.1 sec resolution and fixed activity thresholds, and analyzed their duration and periodicity to detect PLM sequences. Detector performance was quantified by the area under the receiver operating characteristic curve (AUC), sensitivity and specificity.
Results: PLMI ranged 1.4–53.0, with mean 22.5 and 50% > 15. Treating all 15 actigraphy devices independently and comparing with PSG gave AUC 0.85. Setting the actigraphy cutoff to 15 gave sensitivity 0.63 and specificity 1.0. Visual inspection of the EMG revealed three subjects with nearly unilateral PLM. Two of those subjects wore an actigraphy device on the opposite limb as PLM. Excluding those two devices gave AUC 0.95 with sensitivity 0.83 and specificity 1.0 at an actigraphy cutoff of 15.
Conclusion: Leg-worn actigraphy is capable of classifying patients with abnormal PLMI with high specificity and moderate sensitivity. The sensitivity is impaired in patients with predominantly unilateral PLM.
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CONTACTLESS 3D DETECTION OF LEG MOVEMENTS IN SLEEP

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Introduction: Currently, the diagnosis of periodic leg movements during sleep (PLMS) is based on electromyography (EMG) of the tibialis anterior muscles. We analyzed leg movements by automatic 3D video analysis and compared it to detections by conventional EMG.
Methods: Our video analysis system uses a novel 3D near-infrared time-of-flight sensor. The AIT software measures the height profile of the body lying in bed in high spatial and temporal resolution. Changes in this profile indicate motor events. The software assigns these events to the limbs using a dynamic human model and computes selected features in the spatial, temporal and frequency domain.
In a multi-centric clinical study in Austria that was approved by ethical committees, we recorded time-synchronized video-PSG and 3D video sleep data of 41 patients presenting with nocturnal leg movements. Two experienced somnologists annotated the polysomnographic recordings by visual inspection using AASM Scoring Rules 2.4 and compared the results to leg movements automatically computed from 3D data.
Results: Out of a total of 1853 significant leg movements (sLM) seen in 3D and/or EMG, 1718 (92.7%) were detected in 3D, but only 798 (43.1%) by EMG. For the individual patient, this number varied between 9.4% and 90.7%. Overall, 135 (7.3%) sLM were missed in 3D, but detected by EMG. These did not correspond to visible movements.
Conclusion: EMG-derived sLM qualifying for PLMS can indicate either clinically relevant movements or muscle contractions without visible movements. On the other hand, leg movements caused by other than the tibialis anterior muscles are missed in standard PSG recordings, but are visible in 3D. In such cases, 3D video somnography provides more complete and additional diagnostic data as compared to conventional EMG. Depending on the patient, counting sLM of tibialis anterior muscles poses a very unequal measure to individuals.
A substantial advantage of the 3D technology is the no-touch approach: It avoids poor electrode contacts, enables undisturbed sleep and facilitates the procedure of mounting, (re)adjusting and removing electrodes.
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