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Clinical study

Analysis of nocturnal hypokinesia and sleep quality in Parkinson's disease

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ABSTRACT

Nocturnal hypokinesia/akinesia and sleep disorder are believed to be common in Parkinson's disease (PD), but are often underestimated. To date, only a few studies have focused on nocturnal symptoms related to motor function and sleep quality in PD patients, and the assessments were based mainly on the subjective descriptions of the patients. In this study, we assessed the relationships between motor symptoms and sleep quality in 29 PD patients (17 PD patients reporting impaired bed mobility (IBM) and 12 patients without IBM). All the participants were monitored using multisite inertial sensors and polysomnography in sleep-monitoring rooms for whole night. Compared with PD−IBM patients, PD+IBM patients tended to have fewer turning-over episodes and smaller degree turns. Meanwhile, PD+IBM patients had worse Pittsburgh Sleep Quality Index (PSQI) and Parkinson's Disease Sleep Scale (PDSS) scores, and less total sleep time (TST) than PD−IBM patients. Spearman correlation analyses found that the number of turning-over events showed negative correlations with disease duration ($r = -0.378$, $P < 0.05$) and Unified Parkinson's Disease Rating Scale (UPDRS) axial scores ($r = -0.370$, $P < 0.05$). Moreover, TST ($r = 0.505$, $p < 0.05$) and sleep efficiency (SE) ($r = 0.473$, $p < 0.05$) positively correlated with the number of turns in bed. Multivariate linear regression analyses showed that UPDRS axial scores and the number of turns were significantly associated with TST (both $p < 0.05$). In conclusion, the number of turns in bed and UPDRS axial scores were two significant factors affecting sleep quality. Multisite inertial sensors can be used to quantitatively evaluate nocturnal motor functions in PD patients.

1. Introduction

Parkinson's disease (PD) is a chronic progressive neurodegenerative disease that is commonly seen in the elderly. It is characterized by static tremor, bradykinesia, rigidity, postural unsteadiness, and a series of nonmotor symptoms, including sleep disorders, depression, pain, constipation, and genitourinary problems [1–3]. Among the recognized symptoms, nocturnal hypokinesia and sleep disorder are usually neglected but have a significant negative effect on the PD patients as well as their caregivers.

Nocturnal hypokinesia/akinesia is a condition whereby PD patients have difficulty moving at night so that turning over in bed and getting out of bed are restricted [4]. The consequence of these long periods of immobilization and difficulty in changing position may lead to pressure ulcers, predisposition to aspiration pneumonia, and asphyxia, which are potential causes of death in PD patients [5]. However, PD patients are often unable to accurately describe their nocturnal sleep problems and their expectations of improving nighttime symptoms are lower than for daytime symptoms. Concerns related to nocturnal hypokinesia and inability to get out of bed have been raised as the most common nighttime problems in PD patients in two previous studies, published in 1987 and 1988 [6,7]. A survey of 220 PD patients showed that 65% of patients experienced the inability to turn over in bed [7]. In clinical practice, information on nocturnal hypokinesia/akinesia is acquired primarily through medical history, physical examination. The results obtained using these methods are usually influenced by the subjectivity of participants and testers. In recent years, use of multisite inertial sensors has received considerable

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attention for its advantages in capturing real-time data, which helps physicians to obtain quantitative, accurate, and comprehensive results and documents real-life conditions of patients.

Poor sleep quality contributes to the inferior quality of life of PD patients despite appropriate treatment of motor symptoms. Previous studies on the relationship between nocturnal hypokinesia and sleep disorder were sparse and controversial. Two studies showed that nocturnal hypokinesia negatively affects sleep quality in PD patients [3,8]. Moreover, they acquired the information only through interviews but not quantitative data. Another study demonstrated that PD patients with subjectively impaired bed mobility (IBM) had worse sleep quality [9].

To date, only a few studies have focused on nocturnal symptoms related to motor function and sleep quality in PD patients, and the assessments were based mainly on the subjective descriptions of the patients. Therefore, the aim of our study was to evaluate the relationships between symptoms of nocturnal hypokinesia and sleep quality in PD patients by utilizing multisite inertial sensors and polysomnography. Further analyses of the correlations between motor functions, sleep quality, and other clinical rating scales may provide evidence to guide therapeutic interventions and nursing strategies for PD patients.

2. Patients and methods

2.1. Patients

Participants in this study were inpatients of the Second Affiliated Hospital of Soochow University Neurology Department and Sleep Medicine Center from March 2016 to January 2017. Inclusion criteria were: 1) patients diagnosed with clinically established PD and the diagnosis of PD was made according to the Movement Disorder Society clinical diagnostic criteria for PD published in 2015 [1]; 2) all participants provided written informed consent. Exclusion criteria were: 1) diagnosis of Parkinsonian syndrome; 2) a history of undergoing deep brain stimulation; 3) a history of significant memory problems or dementia (Mini-Mental State Examination (MMSE) score <24); 4) a history of restless-leg syndrome, rapid eye movement (REM) sleep behavior disorder or periodic limb movements syndrome; 5) moderate or severe obstructive sleep apnea (AHI $\geq$15); 6) taking sedative-hypnotic medicine, anti-anxiety medicine or anti-depression medicine; 7) experiencing of dyskinesia according to the Unified Parkinson's Disease Rating Scale part Ⅳ (UPDRS-Ⅳ). 8) a history of stroke, definite encephalitis, disease that rendered patient bedridden, neuromuscular disease, or osteoarticular disease; 9) inability to cooperate to carry out the test.

2.2. Methods

2.2.1. Clinical assessment

Motor function assessment included Hoehn and Yahr (H-Y) staging and UPDRS- III. Disease stage of 29 PD patients was rated using the H-Y staging system during the "on" period, and those who were not yet taking any PD-related drugs were evaluated at 10 a.m. In order to accurately assess nocturnal motor functions, 29 PD patients were assessed according to UPDRS-III in sleep-monitoring rooms at 19 p.m. The UPDRS axial score was calculated as the sum of the scores for items 18, 22, 27, 28, 29, and 30of the UPDRS-III [10]. A likert scale (1 = extremely serious to 5 = no discomfort or 1 = all of the time to 5 = never) were designed for PD patients to define their subjective nocturnal hypokinesia symptoms according to two previous studies [3,9]. PD patients had to answer five questions and describe the severity of turning over and getting up in bed, rigidity, tremor, and the need for assistance from caregivers to move their bodies in bed in the last three months. The patient whose total score was less than 13 would be enrolled in PD+IBM group.

All participants were scored using the Pittsburg Sleep Quality Index (PSQI) and Epworth sleepiness scale (ESS). PD patients were additionally scored with the Parkinson Disease Sleep Scale (PDSS). Subjective sleep quality was measured using the PSQI [11], with a higher score corresponding to worse sleep quality. The ESS was used to assess daytime sleepiness [12], with a higher score indicating worse day time sleepiness. The PDSS was used to evaluate sleep quality of PD patients, with a higher score indicating better sleep quality [13]. The main sleep parameters evaluated were total sleep time (TST) and sleep efficiency (SE). We adopted the criteria for sleep stages according to the rules of American Academy of Sleep Medicine (AASM) [14].

All PD patients continued to take oral drugs according to their pre-existing treatment programs. Nine of twenty-nine PD patients were diagnosed with PD for the first time and were not yet taking any PD-related drugs. Overall dopaminergic treatment was quantified by calculating the levodopa (L-DOPA) equivalent dose (LED) in mg/d [15]. In addition, the dopaminergic dose taken before going to bed was calculated in LED and defined as night LED.

2.2.2. Evaluation of nocturnal hypokinesia using multiple sensors

The multisite inertial sensors used in this study were developed by the Suzhou Institute of Biomedical Engineering and Technology, Chinese Academy of Sciences (SIBET CAS). The movement monitoring system is composed of five sensor modules, a data repeater, and a monitoring host computer [16]. The sensor modules, which transfer data to the host computer based on wireless fidelity (WiFi), are fastened with elastic bandage and worn above the nightclothes at the abdomen about 10 cm below the xiphoid and on both wrists and ankles. Parameters assessed include triaxial acceleration, angular velocity, and data can be recorded simultaneously by every module with a 20-Hz sampling rate [16].

Nocturnal parameters assessed in our study consisted of getting out of bed to urinate (nocturia), turning over, and limb movements. The main indices of turning over included degree, duration, velocity, and acceleration. We adopted the criterion applied in previous studies [4,17–20]. We identified getting-out-of-bed activity from the recording by a rapid increase in acceleration in the x-axis of more than 45° from either static or rotational movements [18,19]. We adopted the operational definition of turning over as a series of at least a 15° rotational movement of the trunk from one static position to another that is sustained for at least 5 min in a y-axis plane [19,20]. Limb movement was defined as a change of at least 15° from the previous position, but not necessarily sustained [4]. The movement of limbs was not considered turning over.

The sensor modules and electrodes were attached to participants at 20 p.m. The test began at 21 p.m. and ended at 7 a.m. the next morning. Video recording of each participant was reviewed to ensure the exact time span of monitoring and the accuracy of the interpretation of each movement from the sensors and polysomnography.

This study was in compliance with the guidelines of the medical ethics committee of the Second Affiliated Hospital of Soochow University.

2.3. Statistical analysis

All statistical analyses were performed with SPSS software (version 17.0; Armonk, NY, USA). The normal distribution of continuous variables is shown as mean (standard deviation) and *t*-test was used for comparison between two groups. Variance in skewness distribution is shown as median (range), and a nonparametric

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