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Sleep and impulsivity in Parkinson's disease

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ABSTRACT

Background: Impulsive behavior and poor sleep are important non-motor features of Parkinson's disease (PD) that negatively impact the quality of life of patients and their families. Previous research suggests a higher level of sleep complaints in PD patients who demonstrate impulsive behaviors, but the nature of the sleep disturbances has yet to be comprehensively tested.
Methods: Consecutive idiopathic PD patients ($N = 143$) completed the Minnesota Impulse Disorder Interview and a sleep questionnaire that assessed sleep efficiency, excessive daytime sleepiness, restless legs symptoms, snoring, dreams/nightmares, and nocturia. Patients were also given a Unified Parkinson's Disease Rating Scale motor examination and they completed cognitive testing.
Results: Impulsive PD patients endorsed more sleep complaints than non-impulsive PD patients. The group difference was primarily attributable to poor sleep efficiency (e.g., greater nocturnal awakenings), $p < .01$, and greater daytime sleepiness, $p < .01$, in the impulsive PD patients. Interestingly, restless legs symptoms were also greater in the impulsive PD patients, $p < .05$. The results could not be explained by medications or disease severity.
Conclusions: Poor sleep efficiency, restless legs symptoms, and increased daytime sleepiness are associated with impulsivity in PD. Longitudinal studies are needed to determine whether sleep disturbances precede impulsivity in PD.

1. Introduction

Motor symptoms (i.e., tremor, rigidity, and slowness) are the defining features of Parkinson's disease (PD), however, non-motor symptoms may have a greater impact on patients' quality of life [1]. Of particular interest, PD is associated with an increased prevalence of impulse control disorders (ICDs) [2,3]. ICDs include compulsive shopping, compulsive eating, pathological gambling, dopamine dysregulation syndrome (impulsive dopaminergic medication use), and hypersexuality which involves exhibitionism, incestuous behavior, and even zoophilia [2,4]. Impulsivity can greatly impact the lives of patients and their families; for example, in one case, a PD patient with pathological gambling lost $100,000 [5].

Dopaminergic medication therapy—particularly the administration of dopamine receptor agonists—is associated with an increased risk for ICDs in PD patients by about three times that of those not treated with agonists [6–8]. With the exception of dopamine dysregulation, ICDs in PD patients have been hypothesized to also relate to non-pharmacological etiologies, including individual susceptibilities [5]. Risk of ICD in PD patients is associated with early age of disease onset, novelty seeking, family history of gambling or alcohol abuse, psychiatric symptoms (e.g., greater depression, anxiety, and obsessive–compulsive symptoms), and cognitive impairments [9,10].

A feature of ICDs that has received little attention is associated sleep fragmentation and daytime sleepiness. Sleep deprivation and fragmentation have been linked causally to a lack of control over impulsive behavior in healthy adults [11,12], presumably due to sleep-loss-related impairments in prefrontal cortex top-down inhibitory control [13,14]. Likewise, sleep fragmentation has been linked to impulsiveness in other clinical populations including attention-deficit/hyperactivity disorder (ADHD) [15] and restless legs syndrome (RLS) [16]. Three reports are suggestive of a similar relationship in PD. Nirenberg and Waters [17] reported two cases in which ICD development (compulsive eating) was associated with development of excessive daytime sleepiness. Pontone et al. [18] observed a nominal, but non-significant trend for increased PD patient endorsement of sleep disturbance with ICDs. O'Sullivan et al. [19] had ninety-two PD patients mail in responses to the PD

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sleep scale and observed worse overall sleep scores in impulsive compared to non-impulsive patients.

The above studies [17–19] are suggestive of a relationship between sleep and impulsivity in PD, but they are limited by being either underpowered or by not assessing specific sleep related symptoms. Our goal in the present study was to assess whether impulsivity is associated with sleep disturbances across specific domains: sleep efficiency, daytime sleepiness, nightmares/dreams, snoring, nocturia, and restless legs symptoms. The study included a relatively large sample of 143 PD patients who were administered a battery of validated measures in order to permit firmer conclusions about the presence of any associations.

2. Method

2.1. Patients

The study was approved by the Emory University Institutional Review Board. All participating subjects reviewed and signed an IRB approved consent document. Subject recruitment started February 9, 2009 and ended September 14, 2010. All subjects were recruited from the practices of two neurologists (SAF and AF) in the Emory University movement disorder center. The first 79 participants were also part of an initial cohort of 230 PD patients previously enrolled in a genetics study [20]. The last 73 were not part of that cohort and were recruited consecutively. All patients were evaluated by movement disorder neurologists (SAF and AF) and met standard clinical diagnostic criteria for PD (modified UK brain bank criteria) [21]. Patients were enrolled regardless of age at disease onset, family history of PD, or treatment status (treated or not, with any combination of antiparkinsonian medications). Exclusion criteria included late stage dementia where subjects were unable to complete the visit assessments, history of stroke, findings suggestive of atypical parkinsonism (extraocular movement abnormalities, pyramidal tract signs, ataxia, early dementia), past neuroleptic use, and past history of multiple head injuries with loss of consciousness. One neurologist (SAF) rated patients' motor symptoms in the "on" state using the Unified Parkinson's Disease Rating Scale (UPDRS) [22]. Cognitive status was determined using the Mini-Mental State Examination (MMSE) [23]. Of the recruited sample (N = 152), 143 PD patients responded to both the sleep questionnaire and the Minnesota Impulse Disorder Interview (MIDI) [24]. Demographic information is provided in Table 1.

2.2. Assessments

The sleep questions are listed in Table 2 and were drawn from existing studies (e.g., restless legs epidemiology [25,26]). Patients also completed the Epworth Sleepiness Scale [27], in which they rated how likely they are to doze or to fall asleep in different situations. The MIDI [24] is a semistructured interview used to assess the degree of impulsivity relating to compulsive shopping, hypersexuality, and pathological gambling behaviors.

2.3. Statistical analyses

Presence of impulsivity was determined by a "yes" response to any of the MIDI questions about impulsive buying, gambling, or sexual behavior. For the sleep questionnaire (Table 2), after removing "don't know" responses, we compared sleep complaints between the impulsive PD group and the non-impulsive PD group by using t-tests (Levene's test corrections when necessary). In addition, we summed all "yes" MIDI responses to form a continuous measure of impulsivity and examined sleep–impulsivity associations using Spearman's rho.

Alpha was set to .05, unless otherwise specified. To protect against increases in Type I error, we combined responses on sleep questions to form composites of total sleep complaints (summation of questions 2–6, 9–12; see Table 2), frequency of dreams/nightmares (summation of questions 9–10), restless legs symptoms (summation of questions 11–12), and sleep efficiency (derived from questions 1–4, 7–8). For the sleep efficiency composite we first divided the number of hours sleeping at night (question 1) by the amount of time in bed (absolute difference between questions 7 and 8) and then standardized these values by converting them to z-scores using SPSS statistical software (i.e., the sample mean is subtracted from each individual score and the remainder is divided by the standard deviation). We also calculated the z-scores for questions 2–4 after transforming them with a sign reversal so that higher values represented better sleep efficiency (less fragmentation). The sleep efficiency composite was the average of these four z-score measures.

Table 1
Demographic information (standard deviations in parentheses) across the non-impulsive PD group and impulsive PD group. UPDRS (n = 142), MMSE (n = 141), and medication class (n = 142) information were available for most patients. p values refer to the independent samples t test between the non-impulsive and impulsive PD groups.

	PD total group (n = 143)	Non-impulsive PD group (n = 105)	Impulsive PD group (n = 38)	p value
UPDRS motor scale	17.77 (7.88)	17.46 (7.81)	18.63 (8.11)	.44
MMSE (max = 30 points)	28.21 (1.96)	28.29 (1.91)	27.97 (2.09)	.35
Disease duration (years)	7.95 (4.40)	7.87 (4.12)	8.18 (5.17)	.71
Age (years)	64.71 (9.05)	64.50 (9.17)	65.26 (8.82)	.66
Education (years)	15.76 (2.31)	15.76 (2.21)	15.76 (2.63)	.99
Gender (% female)	35	32	42	.28
Levodopa (% on med)	52	49	62	.15
Dopamine agonist (% on med)	49	48	51	.69

PD = Parkinson's disease; UPDRS = Unified Parkinson's Disease Rating Scale; MMSE = Mini-Mental State Examination.

Table 2
Sleep questionnaire, scale of individual sleep questions, and composite score subdivisions (see 2.3 for composite score calculations).

Sleep question	Scale	Composite
1. How many hours do you usually get at night?		Sleep efficiency
2. How often do you have trouble falling asleep?	1–5	Sleep efficiency
3. How often do you have trouble waking up during the night?	1–5	Sleep efficiency
4. How often do you have trouble waking up too early and not being able to fall asleep again?	1–5	Sleep efficiency
5. When you awaken during the night, how often do you urinate?	1–4	Nocturia
6. How often do you snore in any way?	1–5	Snoring
7. What time do you typically go to bed at night?		Sleep efficiency
8. What time do you typically wake up in the morning?		Sleep efficiency
9. How often do you have a night full of intense, vivid dreams?	1–5	Dreams/ nightmares
10. How often do you have nightmares (frightening dreams)?	1–5	Dreams/ nightmares
11. At bedtime, how often does restlessness in your legs delay your falling asleep?	1–4	Restless legs
12. When you wake up during the night, how often do you feel unpleasant sensations in the leg muscles that require you to move your legs or walk in order to be comfortable?	1–4	Restless legs

Questions 2–4, 6, 9–10: 1 = never, 2 = a few times, 3 = sometimes, 4 = quite often, 5 = usually, 6 = don't know. Question 5: 1 = once, 2 = twice, 3 = three times, 4 = four or more times. Questions 11–12: 1 = never, 2 = occasionally, 3 = often, 4 = very often.

3. Results

3.1. Levels of impulsivity

One hundred and five PD patients were assigned to the non-impulsive group ($M_{\text{MIDI sum}}$ = .0) and 38 PD patients were assigned to the impulsive group ($M_{\text{MIDI sum}}$ = 2.74, SD = 2.89, range = 1–10). Most of these patients showed signs of only impulsive buying (n = 21), though some showed only impulsive gambling (n = 9), only hypersexuality (n = 3), or some combination (n = 5). The impulsive patients and non-impulsive patients did not differ significantly on any of the demographic or disease-related variables listed in Table 1.

3.2. Sleep and impulsivity

The sleep complaint results are listed in Table 3. The impulsive PD group reported significantly more sleep complaints than the non-impulsive PD group, and these sleep complaints were primarily attributable to poor sleep efficiency (e.g., increased fragmentation of sleep), excessive daytime sleepiness (higher Epworth