

The Impact of Deep Brain Stimulation on Sleep and Olfactory Function in Parkinson's Disease

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Abstract: *Objective:* Relatively little is known about the effects of deep brain stimulation on non-motor symptoms. The aim of this pilot study was to assess the impact of deep brain stimulation on sleep and olfactory function in Parkinson's disease.

Methods: Subjective sleep quality and olfactory testing were performed on 11 consecutive Parkinson's disease patients (eight men and three women) undergoing bilateral subthalamic nucleus stimulation. All patients consented to undergo clinical assessments prior to the procedure, and at regular intervals afterwards.

Results: Subjective sleep quality improved at six months following deep brain stimulation and this benefit was sustained in the majority of patients at later follow-up assessments. There was no significant change in olfactory function following deep brain stimulation.

Conclusions: In addition to having beneficial effects on motor function and quality of life, bilateral subthalamic nucleus stimulation improves subjective sleep quality in Parkinson's disease.

Keywords: Deep brain stimulation, sleep, olfaction, smell, Parkinson's disease.

INTRODUCTION

The pathology of Parkinson's disease (PD) extends far beyond the nigrostriatal system, resulting in a variety of non-motor symptoms which cause significant morbidity. Whilst deep brain stimulation (DBS) has been shown to be more effective than best medical therapy in improving motor fluctuations in selected PD patients [1], relatively little is known about its effects on non-motor symptoms. The aim of this pilot study was to assess the impact of bilateral subthalamic nucleus (STN) DBS on sleep and olfactory function in PD.

MATERIAL AND METHODS

We recruited 11 consecutive PD patients (eight men and three women) undergoing bilateral STN DBS at the Essex Centre for Neurological Sciences. All patients consented to undergo clinical assessments prior to the procedure, and at regular intervals afterwards. Local institutional approval was granted for the study and the study was conducted according to the Declaration of Helsinki principles.

Subjective sleep quality was evaluated using the Parkinson's Disease Sleep Scale (PDSS) [2]. This scale – which is validated for use in PD – asks patients to rate 15 aspects of nocturnal and daytime sleep on a linear scale from 0 (bad) to 10 (good). In addition to the overall score

(maximum 150), PDSS questions were combined to assess eight specific sleep sub-domains: sleep quality, sleep onset and maintenance, nocturnal restlessness, nocturnal psychosis, nocturia, nocturnal motor disturbance, sleep refreshment and daytime dozing.

Olfactory testing was performed using the University of Pennsylvania Smell Identification Test (UPSIT), a 40-question multiple choice scratch-and-sniff test [3]. Patients were classified into three groups according to gender-specific cut-off scores: anosmia= <20 ; hyposmia= $20-33$ (men) and $20-34$ (women); normosmia= ≥ 33 (men) and ≥ 34 (women). Other assessments included Unified Parkinson's Disease Rating Scale (UPDRS) part III (motor impairment), Beck Depression Inventory (BDI) (depression) and Parkinson's Disease Questionnaire (PDQ-39) (quality of life).

RESULTS

Mean age at diagnosis was 43 years and mean disease duration at DBS surgery was 134 months. 9 out of 11 (82%) patients had a higher PDSS score at six months compared to pre-DBS assessment, indicating a subjective improvement in sleep quality. PDSS score was significantly higher at six months compared to pre-DBS assessment (mean 113.2 versus 95.9; paired t-test, $p=0.050$). Apart from nocturnal psychosis, there was a trend towards improvement in all sleep sub-domains following DBS (Table 1).

Compared to pre-DBS assessment, the vast majority of patients also had higher PDSS score at later follow-up

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Table 1. Effect of DBS on subjective sleep quality.

PDSS sub-Domain	Pre-DBS	6 Months	% Change	p-value
Sleep quality	5.11	5.79	+53.2%	0.228
Sleep onset/maintenance	6.49	7.19	+17.3%	0.051
Nocturnal restlessness	6.06	7.49	+135.8%	0.206
Nocturnal psychosis	9.15	9.01	-1.0%	0.230
Nocturia	5.69	6.91	+28.0%	0.137
Nocturnal motor disturbance	7.09	7.92	+18.7%	0.457
Sleep refreshment	4.93	6.35	+53.0%	0.136
Daytime dozing	5.61	8.09	+37.0%	0.935

Mean PDSS scores are shown for each sub-domain at pre-DBS and after six month assessments. % change refers to the sum of the difference between PDSS sub-domain scores for each individual patient.

assessments: 7 out of 8 (88%) at one year, 6 out of 6 (100%) at two years, and 5 out of 7 (71%) at three years. No significant difference was observed over the entire follow-up period due to large inter-individual variation (1 way ANOVA, $p=0.159$).

Three patients were excluded from the olfactory analysis due to missing data. All PD patients had an impaired sense of smell prior to DBS (five were anosmic, three were hyposmic). One patient was re-classified from anosmia to hyposmia at six months, but the rest remained the same. There was no significant difference in UPSIT score at six months compared to pre-DBS assessment (mean 20.1 versus 19.6; paired t-test, $p=0.761$).

There was no significant correlation between change in PDSS/UPSIT and change in clinical parameters (UPDRS part III score, BDI score or levodopa equivalent daily dose).

DISCUSSION

Our preliminary results indicate that DBS leads to sustained improvement in subjective sleep quality across a variety of different domains. Previous polysomnography studies have shown that bilateral STN DBS patients have improved total sleep time and sleep efficiency, but no changes in sleep architecture, suggesting that the observed sleep benefit may be due to improved nocturnal motor activity rather than being the direct result of altered sleep physiology [4]. Our results on olfactory testing are in line with Fabbri and colleagues who found no effect of STN DBS on olfactory function [5]. However, three previous studies found significant improvements in odour identification following bilateral STN stimulation [6-8]. It has been suggested that STN DBS may increase neuronal activity in the orbitofrontal and primary olfactory cortices, thereby having a positive effect on the cognitive processing of olfactory information. The differences in study outcomes may reflect small sample sizes, different cohort characteristics and/or different olfactory testing protocols used.

CONCLUSION

Bilateral STN DBS improves subjective sleep quality but we did not observe any significant change in olfactory function. Future studies should consider non-motor symptoms when assessing the effectiveness of DBS on PD patients.

ABBREVIATIONS

BDI	=	Beck Depression Inventory;
DBS	=	Deep Brain Stimulation;
PD	=	Parkinson's disease;
PDQ-39	=	Parkinson's Disease Questionnaire;
PDSS	=	Parkinson's Disease Sleep Scale;
STN	=	Subthalamic nucleus;
UPDRS	=	Unified Parkinson's Disease Rating Scale;
UPSIT	=	University of Pennsylvania Smell Identification Test

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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Declared none.

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