Journal of Neuroinfectious Diseases
ISSN: 2314-7326

Review Article Open Access

Microstructure Forecasts Non-Motor Results after Deep Brain Stimulation in Parkinson's disease

Haidar S Nimsky*

Department of Neurosurgery, Philipps-University Marburg, Marburg, Germany

Abstract

Deep Brain Stimulation (DBS) has emerged as a pivotal treatment for motor symptoms in Parkinson's disease (PD). However, its effects on non-motor symptoms (NMS) are varied and less predictable. Recent advancements in neuroimaging, particularly in understanding brain microstructure, offer promising insights into forecasting these non-motor outcomes. This article explores the role of brain microstructure in predicting non-motor responses to DBS in PD, examining how changes in white matter integrity and connectivity might influence cognitive, emotional, and autonomic functions post-surgery.

Keywords: Deep brain stimulation (DBS); Parkinson's disease (PD); Non-motor symptoms (NMS); brain microstructure; White matter integrity

Introduction

Parkinson's disease (PD) is a progressive neurodegenerative disorder characterized by motor symptoms such as bradykinesia, rigidity, and tremor, as well as a plethora of non-motor symptoms (NMS) including cognitive impairment, mood disorders, and autonomic dysfunction [1]. While DBS targeting the subthalamic nucleus (STN) or globus pallidus internus (GPi) effectively alleviates motor symptoms, its impact on NMS remains inconsistent and unpredictable. Recent research indicates that variations in brain microstructure, detectable through advanced neuroimaging techniques, might underlie these differential outcomes [2]. This article reviews current evidence on how brain microstructure can predict non-motor outcomes following DBS in PD, aiming to provide a comprehensive understanding of the neural underpinnings that could inform patient selection and therapeutic strategies. Brain microstructure refers to the fine-scale organization of brain tissue, including the integrity of white matter tracts and the architecture of grey matter [3]. In PD, neurodegeneration affects these structures, leading to widespread changes that extend beyond the dopaminergic system. Techniques such as Diffusion Tensor Imaging (DTI) and Diffusion Spectrum Imaging (DSI) allow for the in vivo assessment of white matter integrity and connectivity, providing insights into the structural basis of both motor and non-motor symptoms [4].

Discussion

White matter tracts facilitate communication between different brain regions. In PD, degeneration of these tracts, particularly within the cortico-basal ganglia-thalamo-cortical (CBGTC) loops, is implicated in both motor and non-motor dysfunction [5]. DTI metrics such as Fractional Anisotropy (FA) and Mean Diffusivity (MD) quantify white matter integrity, with lower FA and higher MD values indicating microstructural damage. Studies have shown correlations between white matter changes and cognitive decline, mood disturbances, and autonomic dysfunction in PD. Grey matter atrophy in regions such as the prefrontal cortex, hippocampus, and amygdala has been associated with cognitive and emotional symptoms in PD. Neuroimaging studies using voxel-based morphometry (VBM) and cortical thickness measurements reveal significant atrophy in these regions, which may contribute to the non-motor symptomatology [6]. DBS involves the implantation of electrodes in specific brain regions to modulate neural activity. While STN-DBS and GPi-DBS are primarily aimed at reducing motor symptoms, their effects on NMS are heterogeneous. Understanding the predictors of non-motor outcomes is crucial for optimizing DBS therapy.

Cognitive Outcomes: Cognitive changes following DBS are complex and multifactorial. Some patients experience improvements in executive functions and working memory, while others may show declines, particularly in verbal fluency and processing speed. Research suggests that preoperative white matter integrity, particularly in the frontal and parietal regions, might predict cognitive outcomes post-DBS. Patients with preserved white matter integrity tend to exhibit better cognitive resilience following surgery [7].

Emotional and psychiatric outcomes: Mood disorders such as depression and anxiety are prevalent in PD and can be exacerbated or alleviated by DBS. Studies indicate that microstructural integrity of the limbic system, including the cingulum bundle and uncinate fasciculus, is crucial in determining emotional outcomes. Better-preserved white matter in these tracts is associated with more favorable emotional responses to DBS.

Autonomic function: Autonomic dysfunction, including issues with blood pressure regulation, gastrointestinal motility, and sexual function, significantly impacts the quality of life in PD patients. The role of DBS in modulating autonomic symptoms is less understood, but there is evidence that white matter pathway connecting the brainstem and autonomic centers might influence these outcomes. Advanced neuroimaging could help identify patients who are likely to benefit from DBS in terms of autonomic function improvement [8].

Predictive Neuroimaging

Current Evidence and Future Directions

The ability to predict non-motor outcomes of DBS through

***Corresponding author:** Haidar S Nimsky, Department of Neurosurgery, Philipps-University Marburg, Marburg, Germany, E-mail: h.s.nimsky@staff.uni-marburg.de

Received: 01-May-2024, Manuscript No: JNID-24-137522, **Editor assigned:** 03-May-2024, Pre-QC No: JNID-24-137522 (PQ), **Reviewed:** 17-May-2024, QC No: JNID-24-137522, **Revised:** 22-May-2024, Manuscript No: JNID-24-137522 (R), **Published:** 29-May-2024, DOI: 10.4172/2314-7326.1000504

Citation: Nimsky HS (2024) Microstructure Forecasts Non-Motor Results after Deep Brain Stimulation in Parkinson's disease. J Neuroinfect Dis 15: 504.

neuroimaging hinges on the integration of multiple imaging modalities and comprehensive preoperative assessments. Combining DTI, structural MRI, and functional MRI (fMRI) offers a holistic view of brain microstructure and function, enhancing predictive accuracy.

Multimodal imaging approaches: Multimodal imaging combines structural and functional data to provide a more nuanced understanding of brain changes. For instance, combining DTI with resting-state fMRI can elucidate how microstructural integrity impacts functional connectivity, thereby predicting cognitive and emotional outcomes more reliably. Machine learning algorithms applied to these multimodal datasets have shown promise in identifying biomarkers predictive of DBS outcomes [9].

Longitudinal studies: Longitudinal studies tracking changes in brain microstructure before and after DBS are essential for understanding the dynamic nature of neural adaptation. Such studies can identify critical time windows for intervention and reveal how initial microstructural integrity influences long-term outcomes.

Personalized medicine: The ultimate goal is to integrate microstructural imaging into a personalized medicine approach, tailoring DBS therapy to individual patients based on their unique neuroanatomical profiles. This approach could optimize patient selection, improve outcomes, and reduce the risk of adverse effects [10].

Conclusion

Advances in neuroimaging have opened new avenues for understanding the complex relationship between brain microstructure and non-motor outcomes in PD patients undergoing DBS. By identifying microstructural predictors of cognitive, emotional, and autonomic responses, clinicians can better tailor DBS therapy to individual needs, enhancing overall treatment efficacy. Future research should focus on integrating multimodal imaging techniques, conducting longitudinal studies, and developing personalized treatment protocols to fully harness the potential of microstructural forecasting in DBS for Parkinson's disease.

Acknowledgement

None

Conflict of Interest

None

References

1. Wong MM, Brower KJ, Zucker RA (2009) Childhood sleep problems, early onset of substance use and behavioral problems in adolescence. Sleep Med 10: 787-796.
2. Pieters S, Burk WJ, Vander Vorst H, Dahl RE, Wiers RW, et al. (2015) Prospective relationships between sleep problems and substance use, internalizing and externalizing problems. J Youth Adolesc 44: 379-88.
3. Gregory AM, Caspi A, Eley TC, Moffitt TE, O'Connor TG, et al. (2005) Prospective longitudinal associations between persistent sleep problems in childhood and anxiety and depression disorders in adulthood. J Abnorm Child Psychol 33: 157-163.
4. Bauducco SV, Salihovic S, Boersma K (2019) Bidirectional associations between adolescents' sleep problems and impulsive behavior over time. Sleep Med 1: 100009.
5. Peterman JS, Carper MM, Kendall PC (2015) Anxiety disorders and comorbid sleep problems in school-aged youth: review and future research directions. Child Psychiatry Hum Dev 46: 376-392.
6. Goldstein TR, Franzen PL (2020) Sleep difficulties and suicidality in youth: current research and future directions. Curr Opin Psychol 34: 27-31.
7. Roberts RE, Duong HT (2014) The prospective association between sleep deprivation and depression among adolescents. Sleep 37: 239-244.
8. Sivertsen B, Harvey AG, Lundervold AJ, Hysing M (2014) Sleep problems and depression in adolescence: results from a large population-based study of Norwegian adolescents aged 16-18 years. Eur Child Adolesc Psychiatr 23: 681-689.
9. Yeo SC, Jos AM, Erwin C, Lee SM, Lee XK, et al. (2019) Associations of sleep duration on school nights with self-rated health, overweight, and depression symptoms in adolescents: problems and possible solutions. Sleep Med 60: 96-108.
10. O'Neil KA, Conner BT, Kendall PC (2011) Internalizing disorders and substance use disorders in youth: Comorbidity, risk, temporal order, and implications for intervention. Clin Psychol Rev 31: 104-112.