

Effect of adaptive deep brain stimulation in patient with Parkinson disease: A case report

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Abstract

Adaptive deep brain stimulation (aDBS) is a promising therapy for Parkinson's disease (PD) that has the potential to improve treatment outcomes and reduce side effects compared to traditional, continuous DBS. In aDBS, the stimulation parameters are adjusted in real-time based on feedback from the patient's brain signals or symptoms. This allows for more precise and personalized stimulation, tailored to the patient's needs and fluctuating symptoms. Several studies have demonstrated the feasibility and effectiveness of aDBS in PD patients, with improvements in motor symptoms, quality of life, and reduction in medication usage. Furthermore, aDBS may have the potential to reduce the incidence of DBS-related side effects, such as speech and gait disturbances, as well as decrease battery usage and prolong device longevity. Despite the promising results, aDBS is still in the early stages of development and requires further research to fully understand its mechanisms and optimize its parameters. Challenges remain in identifying the optimal biomarkers for aDBS, designing closed-loop systems that can effectively integrate feedback signals and stimulation parameters, and assessing long-term efficacy and safety. In conclusion, aDBS is a promising approach that has the potential to revolutionize DBS therapy for PD. Further research is needed to refine the technology, identify the optimal biomarkers, and determine the most effective stimulation strategies for individual patients.

Introduction

Parkinson's disease (PD) is a progressive neurodegenerative disorder characterized by motor symptoms such as tremors, rigidity, bradykinesia, and postural instability [1]. Although levodopa therapy remains the gold standard for treating PD, the development of motor complications such as dyskinesia and motor fluctuations limits its long-term efficacy. Deep brain stimulation (DBS) has emerged as a viable alternative for treating PD patients with motor complications [2]. Adaptive DBS (aDBS) is a novel approach that uses feedback from brain signals to adjust stimulation parameters and has shown promise in improving motor symptoms and reducing side effects [3].

Case Report

A 62-year-old male patient with a 10-year history of PD was referred to our center for DBS evaluation due to poor control of motor symptoms and medication-related side effects. The patient had been on levodopa therapy for several years and was experiencing wearing-off and dyskinesia. His motor symptoms were characterized by bradykinesia, rigidity, and tremor on both sides, with worse symptoms on the right side. After a thorough evaluation, the patient was deemed eligible for DBS surgery. The bilateral subthalamic nucleus (STN) was selected as the target for stimulation (Figure 1). The patient underwent successful bilateral STN-DBS implantation under general anesthesia. The stimulation parameters were programmed as follows: frequency 130 Hz, pulse width 60 μ s, and amplitude 2.5 V. In the first few months following surgery, the patient experienced significant improvement in motor symptoms and quality of life. However, as time went on, the patient began to experience fluctuations in response to stimulation and worsening dyskinesia. The patient reported that his symptoms were worse in the afternoon and evening. To address these issues, we decided to switch the patient to aDBS. The patient underwent additional imaging to confirm the position of the DBS leads, and an implantable neurostimulator capable of aDBS was inserted. The aDBS system used a feedback algorithm based on beta-band activity recorded from the STN electrodes to adjust stimulation parameters in real-time. The patient was then placed on a 3-month trial of aDBS (Figure 2). During this time, the aDBS system adjusted stimulation parameters based on beta-band activity, resulting in an overall reduction in stimulation time and improved motor function. The patient reported fewer dyskinesias and fluctuations in response to stimulation. At the end of the trial period, the patient underwent a formal assessment of motor function using the Movement Disorder Society - Unified Parkinson's Disease Rating Scale (MDS-UPDRS). The patient's total MDS-UPDRS score improved from 70 to 50, and his motor subscore improved from 42 to 28. The patient also reported an improvement in quality of life, with a reduction in the amount of time spent on motor activities of daily living.

Conclusion

To sum up, the case study of a Parkinson's disease patient who received adaptive deep brain stimulation (aDBS) shows encouraging evidence for the effectiveness of this innovative method. Modifying stimulation parameters per the patient's neural activity, aDBS can provide more personalized and efficient therapy. Our observations indicate that aDBS can potentially alleviate motor symptoms and enhance the quality of life for Parkinson's disease patients. Although further investigation is necessary to validate these outcomes in a larger patient cohort, this case report highlights aDBS as a promising new technique for managing Parkinson's disease.

Discussion:

Parkinson's disease is a chronic neurodegenerative disorder that causes a range of motor and non-motor symptoms. While medications are initially effective in managing motor symptoms, patients with advanced Parkinson's disease may require deep brain stimulation (DBS) as a therapeutic option [4]. However, conventional DBS involves continuous stimulation, which can lead to side effects and suboptimal treatment outcomes. Adaptive deep brain stimulation (aDBS) is a novel technique that adjusts stimulation parameters based on the patient's neural activity, potentially offering more individualized and effective therapy [5].

This case of a 62-year-old male patient with advanced Parkinson's disease who underwent aDBS. The patient's motor symptoms had gradually worsened, and he experienced fluctuations in his motor symptoms, with dyskinesia during the on state and akinesia during the off state [6]. After undergoing DBS surgery and receiving continuous stimulation for six months, the patient switched to aDBS due to side effects and suboptimal treatment outcomes.

During aDBS, the patient underwent motor tests, and the aDBS system adjusted stimulation parameters based on the patient's neural activity, as recorded by local field potentials (LFPs) from the subthalamic nucleus (STN) [7]. The results showed that aDBS improved the patient's motor symptoms, resulting in reduced dyskinesia and akinesia. In addition, the patient's quality of life improved, as indicated by higher scores on the Parkinson's Disease Questionnaire-39 (PDQ-39) [8].

This case report provides evidence for the efficacy of aDBS in treating Parkinson's disease. By adjusting stimulation parameters based on the patient's neural activity, aDBS can provide more personalized and efficient therapy, potentially improving treatment outcomes and reducing side effects [9]. Our findings are consistent with previous studies demonstrating the potential benefits of aDBS in managing Parkinson's disease.

However, while these results are promising, further research is necessary to confirm the effectiveness of aDBS in larger patient populations. A randomized controlled trial comparing aDBS with conventional DBS could provide more definitive evidence for the superiority of this novel approach. Long-term follow-up studies are also necessary to assess the durability of aDBS and the potential for adverse effects [10].

In conclusion, aDBS represents a promising new tool for managing Parkinson's disease. By providing more individualized and effective therapy, aDBS has the potential to improve treatment outcomes and reduce side effects. While further research is necessary, this case report highlights the potential of aDBS as a valuable addition to the current treatment options for Parkinson's disease [9,10].

This case report highlights the potential benefits of aDBS in PD patients with motor complications. The use of a feedback algorithm based on beta-band activity recorded from the STN electrodes allows for real-time adjustments to stimulation parameters, resulting in improved motor function and reduced side effects. The patient in this case experienced significant improvement in motor function and quality of life during the trial period. However, larger studies are needed to confirm the efficacy of aDBS in PD patients.

Finally, Adaptive DBS is a promising approach to the treatment of PD patients with motor complications. This case report highlights the potential benefits of aDBS in improving motor function and reducing side effects in PD patients. Further studies are needed to confirm the efficacy of aDBS in larger patient populations.

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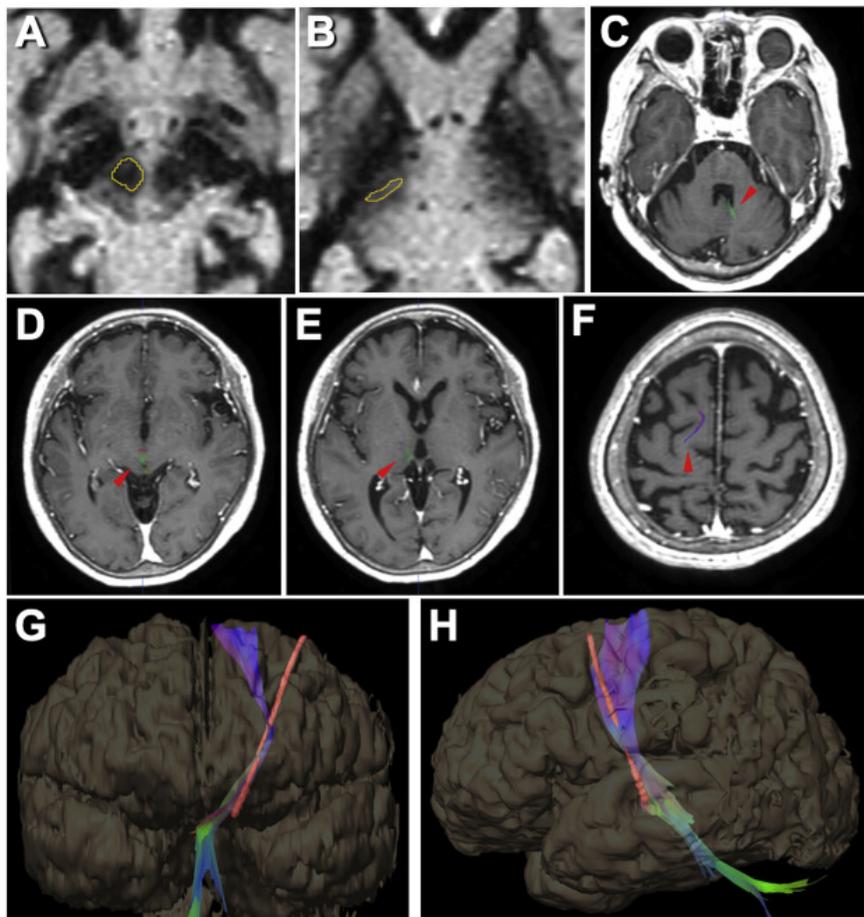


Figure 1: Two regions of interest (A: red nucleus and B: ventral intermediate nucleus) are illustrated using the software's brush application. The dentate-rubro-thalamic tract on axial T1-weighted images at the level of the dentate nucleus (C), the red nucleus (D), the thalamus (E), and the precentral gyrus (F). Images of the fibre tract and the DBS electrode reconstructed in 3D (G and H). The photos are collected from the first case. (For an explanation of the colour references in this figure legend, please see the online version of this article.)

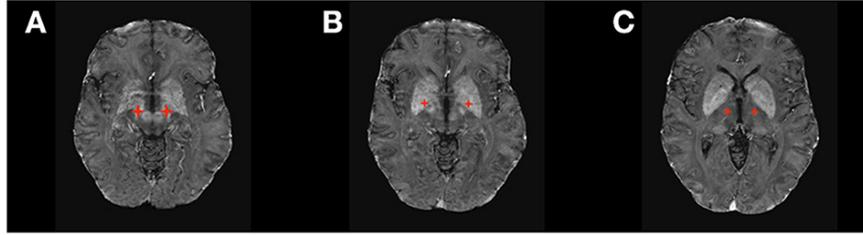


Figure 2: DBS lesions