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CASE REPORT

Deep Brain Stimulation for Parkinson's Disease: Case-Based Insights and Clinical Implications

Rithika Surineni[1], Jason Timmerman[1], Hark Joon Lee[1],
Willard Kasoff[1], Robert A Koenigsberg[1]

ABSTRACT

Parkinson's disease (PD) is a neurodegenerative disorder characterized by motor symptoms such as tremors, rigidity, and bradykinesia, as well as a range of non-motor manifestations. While pharmacotherapy remains the mainstay of PD management, many patients experience inadequate symptom control or adverse effects, prompting the exploration of alternative treatments. Deep brain stimulation (DBS) has emerged as a promising therapeutic option, offering targeted neuromodulation to alleviate motor symptoms and enhance patients' quality of life. This study explores the clinical outcomes of DBS treatment in three PD patients, offering insights into the efficacy, safety, and challenges associated with this intervention. Through the analysis of tremor reduction, functional capacity improvement, and complications following DBS treatment, we aim to illuminate the real-world implications of DBS in clinical practice and contribute to the growing evidence supporting its use in patients with refractory PD. Ultimately the findings underscore the importance of individualized treatment plans and multidisciplinary care to achieve optimal outcomes for PD patients.

Author Affiliations:
[1] Lewis Katz School of Medicine at Temple University, Philadelphia, PA 19140, USA

Corresponding Author: Robert A Koenigsberg, DO, FAOCR, Department of Radiology, Lewis Katz School of Medicine at Temple University, Philadelphia, PA 19140.

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Parkinson's disease (PD) is a progressive neurodegenerative disorder affecting millions worldwide, with prevalence rising due to aging populations. It is primarily characterized by motor symptoms such as tremors, rigidity, and bradykinesia, which severely limit patients' quality of life.[1] Although pharmacotherapy remains the cornerstone of PD management, a subset of patients experiences suboptimal symptom control or substantial adverse effects, necessitating alternative therapeutic approaches.[2]

Deep brain stimulation (DBS) is a procedure that involves implanting electrodes into targeted areas of the brain to electrically stimulate specific nuclei or functional areas. It has emerged as a promising intervention, providing targeted neuromodulation to alleviate motor symptoms and enhance the quality of life for patients with refractory PD.[3-4] This study examines the clinical outcomes of DBS treatment in three PD patients, offering insights into the efficacy, safety, and challenges associated with this intervention. Through the analysis of tremor reduction, functional capacity improvement, and postoperative complications, we aim to contribute to the growing body of evidence supporting DBS as a viable therapeutic option in patients with refractory PD.

METHODS

STUDY DESIGN

This retrospective, single-center case series analyzed the outcomes of three Parkinson's disease patients after deep brain stimulation treatment at Temple University Hospital. The study focuses on illustrating the clinical variability in outcomes following DBS among patients with similar demographic profiles.

PARTICIPANTS

Three PD patients treated with DBS at Temple University Hospital were included in this study. The patients were selected based on their shared characteristics—over 60 years of age and motor symptoms refractory to pharmacotherapy—while aiming to explore variations in clinical outcomes and post-operative complications. This selection provides an unbiased representation of DBS outcomes in typical candidates for this treatment.

DATA COLLECTION

Medical records, including clinic notes, surgical reports, imaging studies, and medication histories, provided comprehensive data on PD diagnosis, symptoms, medication trials, surgeries, and postoperative outcomes. Patient-reported outcomes, including functional improvements and quality of life, were gathered through routine office visits, complementing the clinical data.

OUTCOME MEASURES

Changes in tremor severity, rigidity, bradykinesia, gait disturbances, and medication requirements post-DBS were assessed through a combination of objective clinical measures and patient-reported outcomes, as documented in the medical records. Objective assessments included neurological evaluations of motor symptoms and medication tracking (e.g., reductions or discontinuation of Sinemet). Patient-reported outcomes were gathered during routine office visits, where patients were asked to report on improvements in functional capacity and quality of life. This combination of clinical and subjective measures provided a comprehensive evaluation of the treatment's success.

IRB CONSIDERATIONS

This study did not require IRB approval, as the total number of patients (3) satisfied the criteria for a case series exempt from IRB approval according to Temple University Hospital IRB standards.

CASE PRESENTATION

PATIENT PRESENTATION

Patient A was a 66-year-old male with a family history of tremors who presented with bilateral upper extremity tremors that progressively worsened despite multiple pharmacotherapies. Similarly, patient B, a 69-year-old male, initially experienced tremors and rigidity in his right arm, which subsequently progressed to involve his left arm. Despite increasing the dosage of his medications at this time, the tremors persisted, and he was referred for an evaluation for potential deep brain stimulation. Patient C was a 71-year-old male who experienced left-sided weakness, dysarthria, and tremors following a cerebral artery occlusion that resulted in a cerebral infarction. He was subsequently diagnosed with Parkinson's disease. These three patients were selected because they share common characteristics—male over 60 years of age and motor symptoms refractory to pharmacotherapy—making them typical candidates for DBS. Despite these similarities, the selection was made to explore

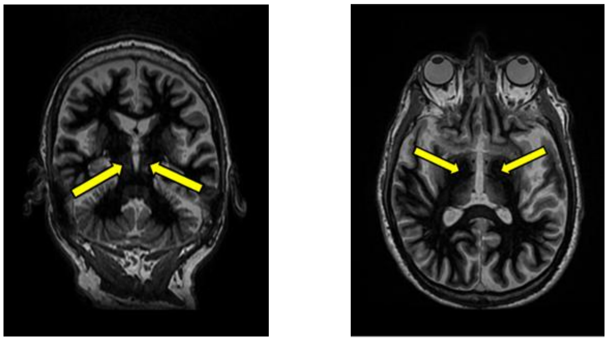

Figure 1. Coronal (L) and axial (R) MRI of the brain.
The imaging demonstrates the subthalamic nucleus (yellow arrow). White-matter-nulled sequence was used to optimize the stereotactic visualization of the subthalamic nucleus.

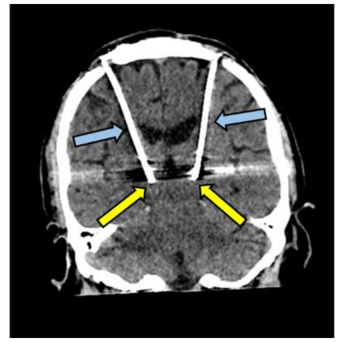

Figure 2. Coronal brain CT.
The CT shows placement of electrodes (blue arrow) in the sub-thalamic nucleus (yellow arrow).

the variability in DBS outcomes, complications, and adverse events in patients with these shared characteristics.

NEUROIMAGING

During the surgical phase of DBS, real-time imaging serves as a crucial tool for intraoperative guidance. As seen in **Figure 1**, preoperative MRI allows surgeons to visualize the subthalamic nucleus or globus pallidus interna, ensuring precise electrode placement within the target nuclei. This maximizes the therapeutic efficacy of the procedure while minimizing the risk of stimulation-related side effects.[5]

Following DBS implantation, imaging remains essential for evaluating postoperative outcomes. As illustrated in **Figure 2**, postoperative imaging with MRI or CT scans enables clinicians to verify the electrode positioning, assess for potential lead migrations, and promptly address any complications.[5-7]

OUTCOMES AND ADVERSE EVENTS

The clinical profiles, pre-DBS symptoms, post-DBS outcomes, and complications of three male patients are summarized in **Table 1**. Patient A underwent DBS surgery and experienced improved hand tremors at 3 months, with significant enhancements noted by 6 months. By the end, patient reported 50% reduction in right-side tremors and 90% reduction on the left side, with improved hand function. Similarly Patient B received DBS surgery and had minimal tremors within 3 months post-surgery, which allowed for the discontinuation of Sinemet due to symptom alleviation. Sinemet is a combination of carbidopa and levodopa, commonly used in the management of motor symptoms in Parkinson's disease. Sinemet remains a cornerstone of pharmacotherapy for Parkinson's disease, although long-term use can lead to complications such as motor fluctuations and dyskinesias, which often necessitate alternative therapies. Patient B experienced improved functional capacity overall. Patient C had DBS surgery and showed overall improvements in tremors at 1 month, though some right leg tremors persisted. These right leg tremors were partially alleviated through further fine-tuning of the DBS device by 3 months.

Patients encountered varied complications following DBS surgery. Patient A developed a skin infection over the cranial sutures

Table 1. Summarized patient demographics, symptoms, outcomes, and interventions.

Patient	Age	Gender	Pre-DBS Symptoms	Post-DBS Outcomes	Complications	Post-Operative Measures
A	66	Male	Bilateral tremors refractory to meds	50% tremor reduction (right), 90% (left)	Skin infection	Post-operative antibiotics, wound care
B	69	Male	Right arm tremor and rigidity, progressed to left arm	Tremor control, Sinemet discontinued	None	None
C	71	Male	Left-sided weakness, dysarthria, tremors post-cerebral infarction	Partial tremor control, improvement with fine-tuning	Cognitive slowing, balance instability	Device fine-tuning, ongoing monitoring

post-surgery, which was managed medically. Post-operative antibiotics were administered to Patient A, but additional preventative measures, such as involving plastic surgery for scalp closure, could further reduce infection risk. Patient C experienced cognitive slowing, balance instability, and intermittent headaches, necessitating ongoing monitoring and adjustments. Given Patient C's history of cerebrovascular disease, these complications were anticipated, and frequent device adjustments were made to address the ongoing cognitive and balance issues. In contrast, Patient B reported no adverse events or complications post-DBS surgery.

CONCLUSION

Deep brain stimulation has demonstrated efficacy as a therapeutic intervention for patients with medication-refractory Parkinson's disease. The notable improvements in tremor reduction and functional capacity observed in these three patients' cases within our study highlight the potential of DBS in alleviating symptoms and enhancing patients' quality of life. Despite these benefits, the occurrence of varied adverse events, ranging from skin infections to cognitive effects, underscores the critical need for vigilant surveillance and timely intervention to address complications associated with DBS surgery. This reinforces the importance of personalized pre-operative planning and individualized postoperative management to optimize patient outcomes.

In conclusion, DBS represents a valuable therapeutic option for PD patients suffering from refractory motor symptoms, providing substantial tremor reduction and functional improvements. Emerging evidence suggests that earlier intervention with DBS may offer even greater benefits, including better motor function outcomes and enhanced quality of life.[8,9] However, the overall success of DBS treatment hinges on a comprehensive approach that includes thorough patient evaluation, meticulous surgical technique, and ongoing postoperative management to optimize outcomes. Continued research and clinical experience will play pivotal roles in refining our understanding of the efficacy and safety of DBS, thereby facilitating its broader application in the management of PD. This case series demonstrates that while DBS offers significant therapeutic potential, it also presents challenges that require individualized care strategies. Additional preventative measures may further reduce surgical risks, such as those seen in Patient A's infection case. Earlier intervention with DBS may improve overall outcomes by mitigating long-term medication side effects, as observed in Patient B's case.[10,11] Future studies should explore the timing of DBS intervention to refine clinical protocols and improve patient quality of life.

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