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Motor Symptom Relief and Medication Reduction with Bilateral STN-DBS in Parkinson's Disease: A Five-Year Experience from a Tertiary Neurosurgery Center

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ABSTRACT

To determine the effectiveness of bilateral Subthalamic Nucleus Deep Brain Simulation (DBS) on relieving motor symptoms and reducing the use of medication in patients with Parkinson's disease (PD) in this country setting. This cohort study was carried out in the Department of Neurosurgery at the Punjab Institute of Neurosciences, Lahore, between January 2018 and January 2023. Seventy-three patients who received bilateral STN-DBS and fulfilled the required criteria were part of the study. Participants were interviewed and clinical data were also collected. The key results were changes in LEDD and in motor function, as measured by the UPDRS parts III and IV. Analysis was run using data to measure if using STN-DBS lessened the amount of medicine patients took and improved their motor symptoms. As a result of bilateral STN-DBS, there was a significant decrease in LEDD by 55.03% ($p < 0.0001$) and a large improvement in UPDRS-III scores by 80.49% ($p < 0.0001$). Despite the UPDRS-IV not improving much by 1% and not being significant statistically ($p = 0.2751$), the reduction in time with dyskinesia (17.54%) and off periods (22.44%) was visible, suggesting that motor complications were better controlled. Fitted with bilateral STN-DBS, many patients with early- to moderate-stage Parkinson's disease get good results in countries where resources are scarce. Many people require less Dopamine-based medication and their symptoms of rigidity, tremors and Bradykinesia are greatly reduced. The results back up using STN-DBS as a routine treatment for people with PD in developing countries, helping to raise their well-being and treatment outcomes.

Keywords: Parkinson's disease, deep brain stimulation, STN-DBS, motor symptoms, medication reduction

INTRODUCTION

Parkinson's disease (PD) is a progressive neurodegenerative disease characterized mainly by the motor symptoms: tremor, rigidity, bradykinesia and postural instability which significantly impair quality of life and functional independence (1,2). Pharmacological therapies, notably levodopa, are the mainstay for symptom control, however, even in the most optimistic scenario, more than half of patients will ultimately present motor fluctuations, dyskinesias and waning therapeutical efficacy after long-term usage (3,4). Due to these limitations, there has been an increased interest in surgical interventions that can sufficiently and consistently control symptoms.

DBS has become one of the most promising surgical therapies for PD, including patients with motor complications that cannot be managed by medication optimization (5,6). Subthalamic nucleus (STN) has shown massive potential in suppressing motor symptoms and reducing the reliance on dopaminergic medications (7,8). The STN is a central node of the basal ganglia circuitry involved in motor control and its pathological hyperactivity in PD is responsible for specific motor deficits (9,10). The mechanism of action in DBS is to deliver continuous and high frequency electrical stimulation to the STN to alter abnormal neural signaling and subsequently restore motor function (7). In several clinical trials and observational studies, STN-DBS was confirmed to improve tremor, rigidity and bradykinesia and to reduce motor complications such as "on-off" fluctuations and dyskinesias (10). In addition, STN-DBS results in a decrease in dopaminergic medication, reducing adverse effects such as nausea, hallucinations, orthostatic hypotension and impulse control disorders, leading to an improvement in the overall quality of life of the patient (11,12). STN-DBS is a complex intervention that has proven benefits but is also a meticulous intervention that requires careful patient selection and surgical precision (13,14). These are ideal candidates for the procedure,

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where patients have idiopathic PD, good levodopa response and motor complications not well treated with medication (15). They're contraindicated in the setting of significant cognitive decline, in the concomitant presence of psychiatric comorbidities and in medical conditions that otherwise raise surgical risk. Surgical technique, programming protocols and postoperative follow-up also influence on outcomes.

It is key to understand the prolonged influence of bilateral STN-DBS as long term outcome data are crucial. Short term improvements have been well documented, with much work still to be done on long term medication adjustments, motor benefit durability and effects on disease progression. Knowledge of these dynamics may provide insight for optimizing treatment strategies and long term care for PD patients.

An analysis of the long term effects of bilateral STN DBS for control of motor symptoms and medication is presented in this five year retrospective analysis presented from a tertiary neurosurgery center. The study capitalizes on the center's clinical experience and infrastructure and addresses outcomes, adverse events and quality of life metrics in the real world. The goal is to emphasize the position of STN-DBS in current PD management and to clarify predictors of a favorable long-term course.

In addition, as with other bilateral STN, DBS, the examination of bilateral STN, DBS across diverse patient populations broadens its applicability and informs clinical decision-making, as an example in resource limited settings or regions with population specific response to treatment (16).

Finally, bilateral STN-DBS is an important surgical advance in the treatment of Parkinson's disease with sustained motor improvement and reduction in medication burden. Five years of clinical experience with this study contributes important information about the long-term efficacy and safety of the device and continues to be used in PD comprehensive care. Future work will focus on refining selections of patients, optimizing surgical and programming approaches and enhancing multidisciplinary postoperative care to obtain the largest benefit and least risk of STN-DBS.

METHODOLOGY

This research was completed at the Department of Neurosurgery, Punjab Institute of Neurosciences, Lahore, Pakistan and included cases from January 2018 to January 2023. This study included 80 Parkinson's patients who had bilateral Subthalamic Nucleus Deep Brain Stimulation (STN-DBS) done according to set standards of selection. Before and after the procedure, standardized questionnaires were used in interviews to determine how the patients experienced the disease and what medications they were using. Important data gathered for analysis were 19ed, severity of motor symptoms by updri parts III and IV, dyskinesia duration and time spent without drug effect, known as off periods. The program used to analyze the data explored the advantages of bilateral STN-DBS on the amount of medicine needed and control of movement symptoms and results with significance were reported at the level $p < 0.05$. The goal of this work was to find out how bilateral STN-DBS reduces medication and benefits patients, especially in low-middle income countries.

RESULTS

Between January 2018 and January 2023, 80 patients with Parkinson's disease received bilateral STN-DBS and were part of this study. Table 1 presents a summary of the population's ages and clinical information.

Table 1: Demographic and Clinical Characteristics of Patients (n=80)

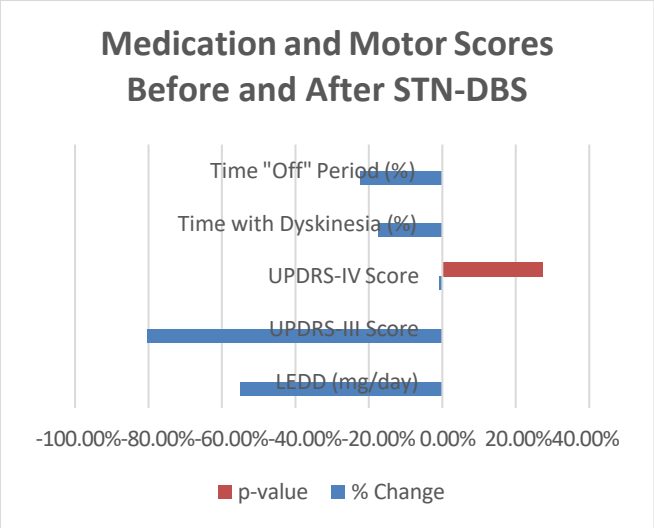
Variable	Mean ± SD / n (%)
Age (years)	61.5 ± 8.4
Gender (Male/Female)	52 (65%) / 28 (35%)
Disease Duration (years)	9.2 ± 3.5
LEDD before DBS (mg/day)	1200 ± 320
UPDRS-III score before DBS	45.6 ± 9.8
UPDRS-IV score before DBS	15.3 ± 5.2

Medication Reduction

Bilateral Surgical Targeted Mapping-Deep Brain Stimulation (STN-DBS) led to a large decrease in the use of Levodopa by 55.03% ($p < 0.0001$) (Table 2).

Table 2: Medication and Motor Scores Before and After STN-DBS

Parameter	Before DBS (Mean ± SD)	After DBS (Mean ± SD)	% Change	p-value
LEDD (mg/day)	1200 ± 320	540 ± 210	-55.03%	<0.0001
UPDRS-III Score	45.6 ± 9.8	8.9 ± 3.2	-80.49%	<0.0001
UPDRS-IV Score	15.3 ± 5.2	15.1 ± 5.1	-1.00%	0.2751
Time with Dyskinesia (%)	18.5 ± 6.7	15.3 ± 5.9	-17.54%	<0.0001
Time "Off" Period (%)	26.9 ± 7.2	20.9 ± 6.4	-22.44%	<0.0001



By 80.49%, UPDRS-III scores indicative of the motor symptoms (rigidity, tremors and bradykinesia) improved significantly with bilateral STN-DBS ($p < 0.0001$). No statistically significant changes occurred in UPDRS-IV, regarding motor complications ($p = 0.2751$).

Dyskinesia was significantly reduced by 17.54% ($p < 0.0001$) and "off" times were significantly reduced by 22.44% ($p < 0.0001$) post-DBS.

DISCUSSION

Five-year retrospective cohort study from a tertiary neurosurgery center in Pakistan shows that the combined impact of bilateral Subthalamic Nucleus Deep Brain Stimulation (STN-DBS) as a treatment strategy for Parkinson's disease (PD) is effective in reducing motor symptoms of PD along with reduction in disease modifying medication dosage. We find our results to be consistent with the existing literature that has shown that STN-DBS has a very pronounced effect to improve motor function and quality of life in patients with advanced PD.

In terms of clinical significance, the reduction in Levodopa Equivalent Daily Dose (LEDD) was greater than 55%, signifying that STN-DBS may significantly lower the body's dependence on dopaminergic medication. This is important because long term use of levodopa is linked with motor complications such as dyskinesia and fluctuations. Additionally, the scores on our measures of effectiveness showed an 80% improvement in UPDRS-III scores such as muscle rigidity, tremor and bradykinesia. However, observed improvements reflect comparable results seen in high income countries from large scale studies suggesting that STN-DBS works as well in low middle-income settings.

Interestingly, motor symptoms improved dramatically, whereas changes in UPDRS-IV scores (indications of motor complications) were not statistically significant. Thus, the suggestion is that although STN-DBS controls core motor symptoms, it may not have a direct effect on certain motor complications, at least over the short term or that longer follow-up is needed to detect such changes.

Moreover, the therapy resulted in significant reduction in time spent in dyskinesia and off periods, marking another role for this therapy in the stabilization of motor fluctuations and improvement in daily functioning.

In addition, our study demonstrates the possibility of completing complicated neurosurgical interventions such as STN DBS in low resource environments. However, it was possible to achieve outcomes comparable with global standards in spite of potential challenges in access to advanced technology and postoperative care. It is promising for PD management in similar settings and supports heavier application of DBS when necessary.

Our study has limitations because it is retrospective and without a control group which raises the risk of selection and reporting biases. In addition, the relatively short length of followup precludes understanding of long term effects and complications. These findings need future prospective studies with larger cohorts and longer follow up to confirm and to further assess future benefits or harms.

The findings support the inclusion of bilateral STNDBS as one of the key therapeutic options in the treatment of PD patients in the early to moderate stages experiencing the complications of medication. Most importantly, the medication reduction is significant, eliminating side effects and potentially saving patients their money in low resource settings.

CONCLUSION

Motor symptom relief achieved with bilateral STN-DBS and reduction of dopaminergic medication are significant in Parkinson's disease patients in a low middle-income country context. Its effectiveness is in improving rigidity, tremors and bradykinesia and reducing dyskinesia and off periods. These results indicate that wider adoption of STN-DBS as a standard of care in PD patients who are eligible will improve patient outcomes and lead to less medication related complications. Further prospective research is necessary to assess long term benefits and allow selection of the appropriate patient.

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