Deep Brain Stimulation for Parkinson Disease: Present Status and Future Subject

ATSUSHI UMEMURA*

*Department of Research and Therapeutics for Movement Disorders, Juntendo University Graduate School of Medicine, Tokyo, Japan

Deep brain stimulation (DBS) is a surgical procedure to treat motor symptoms in Parkinson disease (PD). DBS modulates neurological function of the target region using implanted medical devices to deliver electrical stimulation to the brain. The most common target for PD is the subthalamic nucleus (STN). STN DBS improves motor function in the medication-off state, motor fluctuations and dyskinesia with reduction of dopaminergic medication. Long-term outcomes are favorable for cardinal motor symptoms. However, refractory axial symptoms concerning speech, swallowing, gait and postural stability gradually deteriorated with progression of disease. New strategy to treat these axial symptoms is the future subject.

Key words: Parkinson disease, deep brain stimulation, subthalamic nucleus

Deep brain stimulation for Parkinson disease

Parkinson disease (PD) is a progressive nervous disorder caused by degeneration of dopamine-producing neuron in the substantia nigra. The main symptoms are movement-related, including tremor, rigidity, bradykinesia, postural instability, gait disturbance, etc. Although there is no radical cure for PD, motor symptoms are initially treated with dopaminergic medication.

There is a long history of surgical treatment for PD. Formerly, ablative stereotactic neurosurgical procedures such as thalamotomy or pallidotomy were performed. Currently, deep brain stimulation (DBS) is the most promising surgical treatment option for patients with medically refractory PD. DBS modulates neurological function using implanted medical devices including pulse generator, the electrode in the brain and connecting wire (Figure-1). DBS is an adjustable and reversible treatment. More than 100,000 patients received DBS all over the world1).

In general, a target of DBS for PD is the subthalamic nucleus (STN) or the globus pallidus internus (Gpi). Surgical treatment of PD is based on this functional alteration of basal ganglia (Figure-2). Briefly, lack of dopamine in the substantia nigra induces overactivity of the STN and the Gpi. Increased activity of the STN and Gpi inhibit activity of motor thalamus. The reduced activity of motor thalamus is associated with the hypokinetic symptoms of PD. Therefore, reducing the overactivity of STN or Gpi by high frequency stimulation is effective for hypokinetic symptoms in PD. Currently, the most common target of DBS for PD is the STN1).

As for indication of DBS, the most important thing is correct diagnosis of idiopathic PD. Atypical parkinsonism or secondary PD is not indicated to DBS. The most appropriate candidate for DBS is a
patient who suffers from motor complication of levodopa such as fluctuations and dyskinesia. DBS is also indicated for patients suffering from medication-induced psychotic symptoms such as hallucinations and delusions.\(^2\)

**Effect of STN DBS**

STN DBS improves motor score in the medication-off state but does not alter the score in the medication-on state. STN DBS effectively improves levodopa-responsive symptoms of PD and significantly reduces dyskinesia, motor fluctuation, and the need for dopaminergic medication. Postural abnormality such as camptocormia or Pisa syndrome could be corrected by DBS in some patient.\(^3\)

As for long-term outcomes, improvement of cardinal motor symptoms such as tremor, rigidity, and bradykinesia are well maintained even 5 years after surgery. However, axial symptoms concerning speech, swallowing, gait and postural instability are progressively worsened.\(^4\) These symptoms are refractory to both medication and DBS. The aggravation of axial symptoms reflects the progression of PD itself.\(^5\) New strategy to treat these axial symptoms is the next subject. Rehabilitation with Chinese Tai Chi may improve postural instability.\(^6\)

**Other indications of DBS**

Currently DBS has been established in the management of other movement disorders including intractable tremor and dystonia. In addition, DBS is under investigation in other neurological and psychiatric disorders including obsessive compulsive disorder, depression, Tourette syndrome, epilepsy, addiction, anorexia nervosa, Alzheimer disease, etc.\(^7\)

**References**


---

**Figure 1** Implanted deep brain stimulation (DBS) device

**Figure 2** Functional alteration of basal ganglia in PD

STN: subthalamic nucleus, GPe: globus pallidus internus, SN: substantia nigra.


