Deep Brain Stimulation for Movement Disorders

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KEYWORDS

• Deep brain stimulation • Parkinson disease • Movement disorders • Essential tremor

KEY POINTS

- Movement disorders, such as Parkinson disease or essential tremor, are frequently caused by neurologic diseases, but can also be the result of injuries, infections, a variety of autoimmune disorders, or side effects of certain medications.
- Deep brain stimulation (DBS) has been identified as a therapy for Parkinson disease and essential tremor.
- DBS is reversible, adjustable with significant advances compared with medications.

INTRODUCTION

Movement disorders arise from a disruption in the interaction between the central nervous system, nerves, and muscles.[1,2] Movement disorders, such as Parkinson disease (PD) or essential tremor, are frequently caused by neurologic diseases, but can also be the result of injuries, infections, a variety of autoimmune disorders, or side effects of certain medications. Although early stages of both PD and essential tremor may not require treatment, both are characterized by involuntary or impaired movements that frequently become debilitating and progressively disabling. These and many other movement disorders can be crippling and cause a significant reduction in quality of life for affected individuals, impairing an individual's ability to speak, control fine motor skills, and maintain balance while walking.[2] When the effects of these disorders begin to interfere with daily life, patients frequently seek out treatment from their care providers.

At present, there is no cure for PD or essential tremor. However, many interventions have been used to manage symptoms. Interventions for motor symptoms of movement disorders over the past several decades have included both surgical and medicinal options.[3] Therapeutic efficacy of these options has often been shown to be limited and complications include speech impairment,[4] recurring tremors, and permanent disability.[5,6]

More recent medicinal interventions for these disorders have varying degrees of effectiveness and, as with many treatments, have a risk of adverse effects. Side

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effects for medicinal intervention may include dizziness, nausea, or confusion, with more serious side effects including severe vomiting, convulsions, or bone marrow issues. In addition, medicinal interventions are many and varied, often requiring significant dosage adjustments before efficacy is achieved, which has led to the use of complementary and alternative management for some disorders, like PD. These therapies, interventions, treatments, and practices include tai chi, acupuncture, art, music, and expressive therapies.[7]

Deep brain stimulation (DBS) is a surgical intervention in which electrodes are implanted in specific areas of the brain to deliver high-frequency electrical stimulation. The area targeted depends on the disorder being treated. DBS has been studied for treatment of motor disorders largely based on the rationale that these disorders stem from dysfunction in the basal ganglia, or motor, circuit of the brain.[8] DBS has been clinically proved to be more effective than medical therapy in providing patients with meaningful motor function and increased quality of life while significantly reducing the potential for experiencing adverse events.[9]

PARKINSON DISEASE

Presentation and Diagnosis

PD is characterized by degeneration of dopamine-producing nerve cells and is slow and expanding in its progression. The neurotransmitter dopamine is essential in stimulating motor neurons, or cells that control motor function. When dopamine production is inhibited as a result of malfunction or death of these dopamine-producing motor neurons, the neurons become unable to control movement.

Symptoms resulting from this deterioration include tremors of the extremities and face, bradykinesia (slow movements), rigidity of limbs and the body trunk, slurred speech, and impairment of balance and coordination (postural instability). These symptoms often worsen with anxiety. It is estimated that symptoms appear when the production of dopamine is inhibited by 60% to 80%.[10]

With an estimated prevalence of more than 4 million people worldwide, PD is one of the most common neurodegenerative diseases, second only to Alzheimer disease.[11] Although not considered a hereditary condition, PD has been found to be familial and have a 2-fold to 3-fold increase in individuals who have first-degree relatives with the disease.[12,13]

Research supports not only genetic but also environmental factors as contributing causes of PD. Identified environmental factors include extended exposure to various toxins, metals, or solvents. Other risk factors include[14]:

- Age more than 60 years
- Male gender
- Traumatic brain injuries resulting in amnesia or loss of consciousness
- Genetic predisposition

Clinical Management

The current standard for clinical management of early-stage PD is oral levodopa treatment,[11] which shows high success rates in patients with PD. However, early initial treatment of levodopa may require high doses in order to overcome peripheral degradation. Although initial improvement is often seen, increasing doses involve complications, which can include long-term extreme dyskinesia. After dosage modifications, which may include the addition of peripheral decarboxylase inhibitors, degradation of medicinal effect can be reduced, which may result in required long-term lower doses with reduced side effects.[15]