

Neuroscience Clinic

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Learn About Neurosurgical Procedures

Deep Brain Stimulation

About Deep Brain Stimulation

Chronic deep brain stimulation in its present US FDA - approved manifestation is a patient - controlled treatment for tremor that consists of a multi-electrode lead implanted into the ventrointermediate nucleus of the thalamus. The lead is connected to a pulse generator that is surgically implanted under the skin in the upper chest. And an extension wire from the electrode lead is threaded from the scalp area under the skin to the chest where it is connected to the pulse generator. The wearer passes a hand-held magnet over the pulse generator to turn it on and off. The pulse generator produces a high - frequency, pulsed electric current that is sent along the electrode to the thalamus. The electrical stimulation in the thalamus blocks the tremor. Most users turn the unit off at night. The stimulus parameters can be adjusted to provide the best response and minimize adverse reactions. The pulse generator must be replaced to change batteries, which should last 5 years. Risks of DBS surgery are intracranial bleeding, infection, and loss of function.

This medical device, called the Activa® Tremor Control System, is manufactured by Medtronic Corporation, a company that has produced a line of neurological pulse generators similar to Activa®. It was approved by the US FDA in August 1997 for use in patients with essential tremor and tremor predominant Parkinson's Disease. The device, which has been used longer in Canada, Europe and Australia than in the US, has had a good success rate when compared to the standard medications. Parkinson's tremor differs from essential tremor in two ways. Parkinson's tremor occurs at a lower shaking frequency when the body or limbs are at rest and ceases during purposeful movement. Essential tremor has a higher shaking frequency and is most obvious during intentional movement.

Leading up to FDA approval, Parkinson's and essential tremor patients were studied after deep brain stimulation of the ventrolateral thalamus in the US and in Europe. According to the FDA, patients with essential tremor showed a reduction in tremors that enabled them to carry out daily living activities such as eating, drinking and writing. In contrast, most Parkinson's patients did not show improvement with daily living activities, and in some cases their symptoms worsened and they experienced depression. Some Parkinson's patients were able to adjust downward their medication dosages. There are no long-term clinical studies of this device to evaluate either its safety or its effectiveness when compared to other neurosurgical procedures.

Adverse reactions from thalamic DBS are lessened or disappear when the

stimulation is decreased or halted.

These include:

- tingling sensation (paresthesia) in the head and hands
- depression
- slight paralysis (paresis)
- slurred speech (dysarthria)
- loss of balance
- impaired muscle tone (dystonia)

Safety Issues

Assuring the long-term safety and effectiveness of Aactiva® is the responsibility of the manufacturer, monitored by the FDA. Some of the issues of concern to the FDA include replacing electrode wires, which broke in patients during the pre-approval studies, and the effect of long-term stimulation on brain tissue.

Implant Sites for DBS and Indications

- **Ventrolateral nucleus of thalamus**
 - High frequency stimulation of chronically implanted deep brain stimulators (DBS) in the Vim thalamus is an effective method to suppress tremor of various origins. Vim thalamic stimulation will eliminate 90-100% of tremor in Parkinson's and 90-95% tremor in Essential Tremor.
 - Implanted electrode stimulation is the surgical treatment of choice for the second thalamic surgery in cases where symmetrical tremor exists. A deep brain-stimulating electrode is implanted contralateral to the original thalamotomy, rather than risk the motor and speech deficits that occur in bilateral thalamotomy.
 - Thalamic stimulation may reduce L-dopa requirements in Parkinson's patients.
- **Globus pallidus**
 - **Intraoperative Stimulation**
 - At the Iacono Neuroscience Clinic, intraoperative stimulation in the anterior pallidal regions in 62 patients undergoing posteroventral pallidotomy for the treatment of Parkinson's disease resulted in an immediate reversal of akinetic states despite enforced abstinence of medications.
 - **Globus pallidus DBS is capable of improving Parkinson's akinetic symptoms.**
 - The Iacono Neuroscience Clinic conducted DBS in a patient who had a [four-year history of Parkinson's disease with severe "on-off" and disabling progression of symptoms on chronic levodopa therapy.](#)
 - After obtaining FDA approval two years prior to global approval of Aactiva®, we implanted a Medtronic deep brain stimulation lead stereotactically into the right anterior pallidum contralateral to her most symptomatologic side. Intra-operative stimulation trials at 100 Hz caused reproducible reversal of akinetic symptoms and simultaneous microelectrode recording of the posteroventral pallidum revealed decreased neural activity during anterior pallidal stimulation.
 - **Six months after implantation, the total UPDRS score was**

decreased from 68 to 8 and Hoehn and Yahr Staging improved from 3.0 to 1.5 during periods of chronic high frequency stimulation. Dramatic improvements in tremor, dystonia, bradykinesia, and akinesia were noted within seconds of stimulator activation and were also objectively measured using a computerized data glove. This case reveals the potential for therapeutic pallidal stimulation for Parkinson's akinetic symptomatology.

- **Subthalamic nucleus stimulation**
 - Subthalamic DBS is capable of reversing akinetic Parkinson's symptoms, in accordance with the PD model of hyperglutaminergic activity, but many require bilateral implantation for symmetrical results.

Promise of DBS

According to NINDS, the promise of DBS is in its potential to reorganize neural circuits and brain function. Electrical stimulation may also alter the response of neurons to signaling molecules and, perhaps, to drugs. First, research is required to explain how DBS works.