Subthalamic Nucleus Deep Brain Stimulation (STN-DBS)

A Neurosurgical Treatment for Parkinson's Disease

Parkinson's Disease

Parkinson's disease is a common neurodegenerative disorder that affects about 1:100 individuals over the age of 60. In a small percentage of the population it may be seen before the age of 40.

The cause of Parkinson's disease is not known. However, it is known that some of the symptoms develop due to a loss of dopamine-producing neurons in the substantia nigra, located in the brain stem. Dopamine is an important neurotransmitter required for normal movement and mood control. The degenerative changes in the substantia nigra are thought to begin many years prior to the onset of symptoms. When symptoms appear when about 80% of the dopamine-producing neurons have been lost.

The Classic Signs of Parkinson's Disease

- Tremor at rest (in arms and legs)
- Bradykinesia (slowness of movement)
  - micrographia (hand writing has become smaller)
  - a masked appearance (or loss of facial expression)
  - general slowing of normal movement (walking, turning, hand movement)
- Cogwheel rigidity (resistance to passive movement, determined by the physician)
- Gait abnormalities (abnormalities related to walking)
  - stooped posture
  - decreased arm swing
  - small shuffling steps
- Unstable posture (tendency to lose balance)

The diagnosis is always made by a physician's clinical assessment. A CAT scan or an MRI may be done to rule out other conditions.

Surgical Considerations

Parkinson's disease is a slowly progressive condition and, after 5-10 years of medical treatment, the medications will generally not be as effective as they once were. People may experience abnormal involuntary movements, referred to as dyskinesia, a side effect of the medication. In addition these people may begin to experience severe fluctuations of movement with sudden and unpredictable periods of immobility alternating with periods of too much movement. It is for this type of person that surgery would be considered. STN-DBS may also be considered for people who are having symptoms of

Parkinson's disease (akinesia, rigidity, tremor), as well as motor fluctuations and/or are intolerant to levodopa and other anti-Parkinson medications.

Neurosurgery for the control of moderate to severe Parkinson's symptoms should not be considered unless every attempt has been made to improve the patient's condition with the use of medication. The decision to have surgery should be taken seriously as there is an element of risk. As well, there are certain criteria which must be met before the person can be considered for surgery.

The History of STN-DBS

The basal ganglia, structures deep in the center of the brain, have long been known for control of movement. In Parkinson's disease the subthalamic nucleus (STN), one of the structures in the basal ganglia, is indirectly affected as a result of the loss of the neurotransmitter, dopamine. The STN becomes overactive resulting in too much of an inhibitory effect, which in turn makes movement difficult for people with Parkinson's disease.

In 1993, Dr. Benabid and associates in France started to perform bilateral deep brain stimulation (DBS) in the subthalamic nuclei of patients with disabling akinetic-rigid Parkinson's disease and severe motor fluctuations. The surgeries showed that the electrical stimulation of the STN decreased the severity of symptoms off medications and that the dose of levodopa could be reduced. Other medical centers have documented similar results with an improvement in bradykinesia, tremor, dyskinesias, and possibly gait, as well as a reduction in requirements for levodopa.

DBS is a technique using a stereotactic procedure where a small lead (a very thin insulated wire electrode) is implanted into the subthalamic nucleus. The lead is connected to an impulse generator (battery) by way of a small wire. The impulse generator delivers electrical impulses which stimulate the area resulting in symptom improvement. It is, therefore, somewhat like a cardiac pacemaker.

The surgery is done in 4 stages. The first surgery consists of implanting the electrode on one side of the brain. It can be a long day and the patient is awake during the implantation stage as the surgeon requires the patients assistance and cooperation. There is a clinic nurse present during surgery for comfort and support. After surgery the patient will have an external wire which is used to test the stimulator to help determine the placement and benefit of the surgery before continuing on with the next stage. A few days later the patient will go back to the operating room to have the external wire removed. This is a short operation that will be done with local anesthetic. A few weeks later the patient will return for the third part of the surgery, which is the same as the first surgery only on the other side of the brain. Again the patient will be awake for the surgery. A few days later the patient will return to the operating room to have the generator implanted. The patient will have general anesthetic, and be asleep while Dr. Kiss implants the generator in the chest area.

The amount of stimulation needed to control the Parkinson symptoms are adjusted by the nurse at the clinic, with Dr. Kraft supervising any reductions in medications. Initially these adjustments may need to be done frequently (every 1-2 weeks) until the proper settings are determined. With this system the patient will have a therapy controller that allows them to turn on and off the stimulator as well as change the settings slightly within a range that is determined by the nurse.

The Risks due to Surgery

All surgery carries some element of risk. For STN-DBS the risks of complication are low but may include any of the following:

- 1:200 (0.5%) chance of death due to hemorrhage
- 2 to 3 % chance of a major complication such as a stroke, hemorrhage/bleeding
- 10% chance of permanent numbness, weakness, speech and/or swallowing problems, drooped face, bladder urgency or frequency, or difficulty with concentration and memory
- 40% chance of mild, transient occurrences of the above side effects
- Small chance of seizures or infection
- Transient confusion, depression, memory problems or personality changes
- Headache

Initially, periodic adjustments in programming the stimulator will be needed. During this adjustment period some people may experience the following side effects:

- Transitory, but mild changes in sensation in a limb or a small area on the face
- Occasional transient dizziness or feeling of being lightheaded

Risks due to the Implanted Stimulator

The overall risk of any these hardware-related complications (all of which are treatable but may require repeat surgery) over 4 years is 20%, meaning about 5% per year.

- Infection / rejection / breakage of hardware
- Malfunction of hardware

The generator for the DBS usually lasts about 3-5 years, and replacement requires minor surgery. It is expected that in the next few years there will be a re-chargeable generator.

Personality and Mood Changes

People who have a history of depression, anxiety, mania or other psychiatric disease may find these problems worsened after surgery. There have been reports of an increased suicide risk in patients who have had this procedure. Negative personality traits such as aggressiveness and agitation as well as addictions including gambling, alcoholism or other substance abuse may become much more prominent following surgery. It is very important that you discuss such issues with members of the surgical team. Referral may be made to a psychiatrist before surgery to assess and minimize these risks and can occur at any time if problems arise later on. In some cases these problems can be improved by changing the stimulator settings.

Preparation for Surgery

A decision to consider surgical treatment is made during doctor-patient discussions on management of the condition. The patient is then referred for surgery by their neurologist. The patient is assessed by Dr. Kraft, Dr. Kiss, and Karen RN or Pia RN to determine whether the patient will meet the criteria for surgery. It is important that the patient has reasonable expectations and goals for surgery. If the patient meets the criteria and is agreeable to proceed, a number of baseline assessments are arranged before the patient is booked for surgery. The baseline assessments may include: a CT or an MRI of the brain, neuropsychological testing, and a video taping session along with some additional testing and counseling by the nurse coordinator. The nurse will review the planned surgical procedure with the patient and family members, providing an opportunity to ask any questions they may have.

In Hospital

The patient will be admitted to hospital early in the morning the day of surgery. After admission the patient will go to a day unit and from there will be taken to the MRI department in radiology where they will be fitted with a very special frame which will be secured to the head. An MRI will be done with the frame on to obtain the necessary coordinates to be used for calculations during surgery.

The patient will then be taken to the operating room where the procedure will take place. It is very difficult to determine exactly how long the surgery will take. Relatives will need to wait patiently for news from the operating room or recovery room. One of the nurses from the Movement Disorder Clinic will keep the relatives informed as to the progress of the surgery. If all goes well the patient will be discharged from the hospital by the end of the week

After surgery Dr. Kiss will either meet with the family or call to discuss the surgery. It may take from one to several hours before relatives can visit with the patient after surgery.

The patient will return to the Movement Disorder Clinic one week after discharge to see the nurse-clinician for suture removal and incision check. The nurse will keep in touch

by telephone to make an appointment in about 1 month for programming. Patients may experience a temporary improvement with their Parkinson's symptoms after surgery. It is important that this benefit is gone before programming is started. The majority of patients will still need to continue medications after surgery to achieve the optimum benefit.

The Cost

In Alberta, the surgical procedures and any support services are covered by the Alberta Health Care. Special authorization may be obtained for patients outside of Alberta to have the surgery in Alberta. If you are not a resident of Canada, contact the administrator of your health insurance plan to ask if you are eligible for coverage.

Subthalamic Nucleus Deep Brain Stimulation Surgery

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