

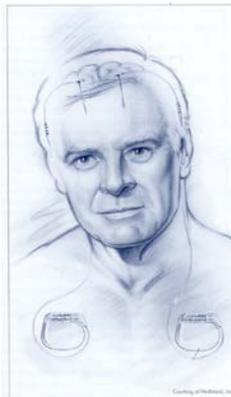


Deep Brain Stimulation (DBS) for Patients with Parkinson's Disease (PD)

What qualifications are needed to be approved for DBS?

1. Advanced PD symptoms not responding to best medical therapy *with symptoms that still respond to levodopa. The best surgical candidates have a big difference between their “on” and “off” symptoms.*
2. Good general health.
3. Good cognition (memory, organization, language, visual-spatial, attention, mood).
4. MRI of brain shows little or moderate brain shrinkage (atrophy) and no other abnormal areas that could increase the risk of brain surgery.
5. Reasonable expectations.

What is the surgical process?



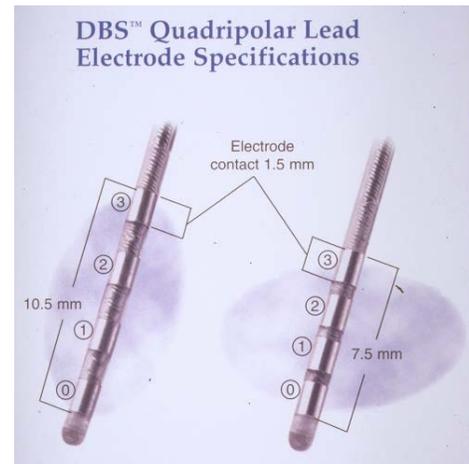
1. Once approved for DBS surgery, patients will have **two surgeries**. In the **first surgery**, DBS electrodes are implanted into the right and/or left sides of the brain. The electrode implanted into the right side of the brain affects the left side of the body and the electrode implanted into the left side of the brain affects the right side of the body. Patients typically go home the next day from the hospital. In the **second** surgery (usually a couple of weeks later), the DBS connector wires and the implantable pulse generator (“IPG”,



battery) are placed in the chest under the skin.

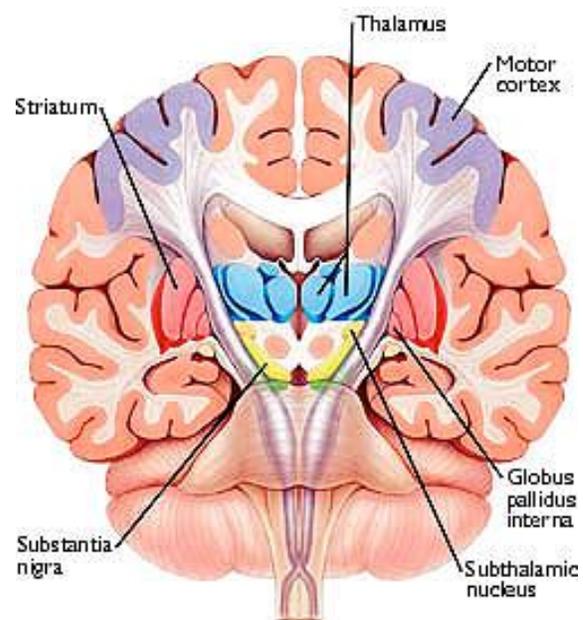
Patients can usually go home the same day.

2. The newest models provide advanced programming features that allow for fine tuning and customized therapy. The Activa PC is a dual-channel device that can control both electrodes. The Activa RC is also a dual-channel device but has a rechargeable battery. The Activa SC is a single-channel device that controls one DBS electrode. Patients with the Activa SC needing two electrodes will need to have an IPG implanted on each side of the chest. The older Soletra and Kinetra models have been discontinued.
3. About a month after your electrodes are implanted, we program the DBS using a hand-held computer. Once activated, the DBS electrode delivers small amounts of electrical current into the target brain area. You will also be given a home programmer that allows you to adjust your deep brain stimulation, if needed.
4. The electrical current blocks or changes the firing pattern of nerve cells to improve PD symptoms.



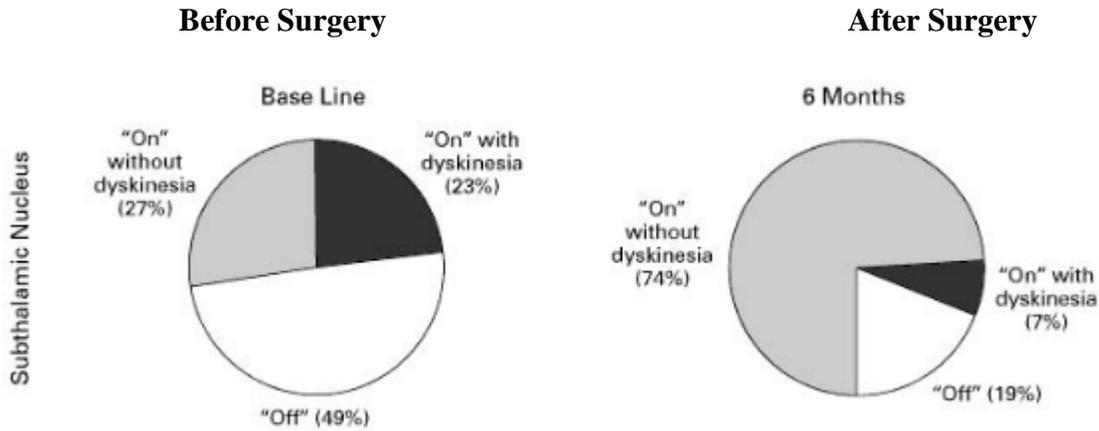
What is the difference between STN and GPi?

The subthalamic nucleus (STN) and globus pallidus internus (GPi) are two target locations for DBS in patients with PD. A recent study showed that both of these sites have similar success rates in treating the main motor symptoms of PD¹. Your surgical team will decide which implantation site is best for you.





What are the benefits of DBS?



Sources: *Deep-Brain Stimulation for Parkinson's Disease Study Group. (2001). Deep-brain stimulation of the subthalamic nucleus or the pars interna of the globus pallidus in Parkinson's disease, New England Journal of Medicine, 345(13), 956-63*

1. Studies of DBS that was implanted on both sides show that patients have an average of 6 hours/day more “on” time after surgery. The severity of “off” time is also reduced by about 50%.
2. Most patients require less medicine after bilateral DBS. On average, patients need less PD medication after DBS; however, some patients seem to require almost the same dose of medicine as before surgery together with DBS to have the best function.
3. A study published in 2003 evaluating patients who underwent bilateral subthalamic nucleus (STN) DBS showed that patients still had a 50% improvement in their PD motor symptoms five years after surgery; however, speech, slowness, balance and freezing difficulties in the “on medication state” did worsen over the 5 years, as would be expected in a progressive disorder². Patients gained an average of 6.6 pounds after surgery in the first year, and weight was stable afterwards.

Do some symptoms improve more than others with DBS?



1. For each patient, *the symptoms that improve the most with medication* before surgery *will improve most with DBS. Tremors* will likely be much better with DBS than with medication.
2. *Dyskinesia* typically improves a lot after surgery, probably because patients are taking less medication.
3. Most patients report much less “turning on” or “wearing off” symptoms after DBS.
4. *Freezing of gait* will likely improve with bilateral DBS **if** it is better in the “on” state before surgery. If patients still “freeze” when they are “on” before surgery, DBS will likely not help this symptom.
5. *Falling* will improve after DBS **if** it is improved with medication. If medication does not help prevent falls when patients are “on”, then falls are not likely to improve after DBS.
6. Most patients with difficulty sleeping due to PD will have improvement in sleep after surgery.

Can some symptoms get worse with DBS?

1. *Speech* can get worse after bilateral DBS. The reason is not clear, but it is due to DBS. The voice may be softer. Speech may be slightly slurred or stuttering may occur.
2. Some patients *fall* more after bilateral DBS. This may be due to excessive relaxation of muscles that were very tense before surgery. Some patients will need to use a walker to prevent falls after surgery.
3. A delayed side effect may be *difficulty opening the eyes* or keeping them open. If this occurs, it can be improved by adjusting PD medication or DBS settings. It may also improve with Botox injections into the affected eye muscles.



What are the risks of DBS?

1. The most serious risk of surgery is bleeding or bruising in the brain or loss of blood flow to the brain. In most cases the bleeding is very small and causes no symptoms. It resolves on its own over time. In rare cases, however, this can result in impaired speech, thinking, or vision; numbness, paralysis, or even death. In centers where many DBS procedures are performed, this risk is usually less than 2% for any bleed and less than 1% for a bleed that causes permanent injuries.
2. The second most serious risk is of *heart, breathing or other medical problems* that occur during or after surgery as a result of the stress of surgery. Rarely, this can result in heart attack, blood clots to the lungs, pneumonia, air emboli or other serious and potentially fatal conditions. The risk of these complications is also very low (<2%). We require medical clearance prior to surgery to reduce the chance of having a medical complication.
3. Some patients may have a *seizure* during or after DBS surgery due to irritation of the brain cells. If this occurs, we prescribe medicine to prevent further seizures for about 6 months. This is rare and occurs in less than 5% of patients.
4. *Infection* is a more common risk because DBS involves placing foreign objects in the body. Germs can enter the incisions and cause an infection. Infections are serious and may result in the need to surgically remove all or part of the DBS system. Patients may be treated with IV antibiotics for 6 weeks, but re-implantation of the DBS component may be delayed for up to 6 months. The risk of serious infection is at least 5%. We take meticulous care to reduce the risk of infection and will advise you on how to care for your incision.
5. Some patients may become *confused or hallucinate* during or after DBS surgery. If this occurs, it typically lasts less than 1 week but may require a longer hospitalization. The symptoms usually resolve with medication adjustment.
6. Rarely, patients can have *difficulty with urination* and need a catheter after surgery.
7. Some patients have *mood changes* after DBS including excessive energy, restlessness, impaired judgment, and/or being more quiet, withdrawn, anxious or depressed than usual.



All mood changes need close monitoring and generally improve within a few weeks to months. If this occurs, be sure to tell our staff as soon as possible.

8. All patients in our program undergo comprehensive cognitive testing before being approved for surgery as DBS surgery can worsen dementia symptoms. Some patients with mild to moderate thinking problems not severe enough for a diagnosis of dementia can have the DBS surgery; however, there is still a small chance of developing worsening *memory or thinking problems* or dementia following DBS surgery.
9. A small number of patients have had more *falls* after surgery, especially in the first few weeks. We will remind you as you are discharged from the hospital to take extra precautions at home to avoid falling as falls can cause serious injuries.
10. Our surgical team will strive to perform your surgery with the highest possible degree of accuracy to insure the best possible results, however, there is a small risk that this surgery will not improve your PD symptoms to the degree expected.

When is the DBS system initially turned on?

1. Programming begins about 1 month after surgery. *You will hold your Parkinson's medications the day of your initial programming so you arrive "off"*. We see patients for programming every 1-4 weeks until the optimal effects are seen; however, this varies for each person. It may take 3-6 months after surgery for a patient's symptoms to stabilize. As we adjust the DBS, we will also re-adjust the medication schedule. Once symptoms are stable, we will check your generator every 6-12 months.

Who will program my DBS?

Dr. Zhang, Dr. Wheelock, Dr. Malhado-Chang or Nurse Practitioner Laura Sperry will perform the initial programming and the first several adjustments. Once your settings are stable, you may return to your regular neurologist for follow-up care. Depending on your neurologist's experience with DBS programming, we may request that you return to U.C. Davis to have your DBS system checked every 6-12 months. The purpose of these follow up visits is to monitor when your implantable pulse generator (battery) needs to be replaced.



What are the side effects of DBS?

1. During the initial programming we start with the lowest possible current and gradually increase the current until side effects occur. Common side effects from DBS may include blurred or double vision, tingling on one side of the body, pulling feelings in the face or limbs, soft or slurred speech, and odd uncomfortable feelings in the head. Rarely patients can have mood changes or trouble opening the eyes. Most of these symptoms are stopped by changing or turning down the DBS current.

Is DBS reversible? What if there is a cure found for PD?

DBS is considered to be reversible because the electrode(s) can be turned off. If new therapies that help PD more or cure PD are developed, the system can be turned off and/or surgically removed.

Should I have DBS on one or both sides?

Neurosurgeons usually implant bilateral DBS on the same day in most patients. Most people with PD improve much more with bilateral DBS; however, our team may recommend doing one side first for certain patients.

Are there alternatives to DBS?

Other alternatives to DBS include adjusting medications, physical therapy, speech therapy, and exercise. For some patients, the ablative surgeries called pallidotomy or thalamotomy, where the surgeon destroys a few carefully-mapped brain cells, can be a good alternative. These procedures provide excellent tremor and dyskinesia relief, but cannot be performed bilaterally due to side effects. Therefore, patients can have relief of symptoms on only one side of the body.

**Are there any safety issues associated with DBS equipment?**

Yes. In most cases, DBS is not compatible with MRI, or with exposure to strong electromagnetic fields. Patients with DBS cannot have diathermy (therapeutic ultrasound). Please see the handout about Medical Safety Issues for more details.

What changes should I report prior to my scheduled surgery?

Please be prepared to bring along a copy of your current medication schedule. Please call our clinic if you experience any health changes prior to your scheduled surgery, including any hospitalizations, infections, new medical diagnoses, serious injuries or mood difficulties. We strive to work with your physician to optimize your health before your surgery in order to reduce the chance of complications.

**PLEASE CALL OUR OFFICE IF YOU HAVE ANY QUESTIONS OR CONCERNS:
Neurology Clinic: (916)734-3588 or Neurosurgery Clinic: (916) 734-4300.**

Footnotes

1. Krack P et al. (2003). Five-year follow-up of Bilateral Stimulation of the STN in Advanced Parkinson's Disease, *New England Journal of Medicine*, 349(20):1925-34
2. Weaver FM et al., Randomized trial of deep brain stimulation for Parkinson disease: Thirty-six-month outcomes, *Neurology* 2012 Jul 3; 79:55