



Parkinson's
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Deep Brain Stimulation

There has been renewed interest in surgical techniques to treat Parkinson's disease. This follows the realisation that although the drug treatment for Parkinson's (particularly levodopa) is usually initially dramatically effective, its long-term use is complicated by drug intolerance and side effects that are difficult to manage in some people.

Deep brain stimulation (DBS) is a form of surgery that is used to treat some of the symptoms of Parkinson's. It was pioneered in the 1980s by a research team in Grenoble, France, led by Professor Benabid and Professor Pollack, and is now performed at many centres, including several in the UK. DBS is not suitable for everyone who has Parkinson's. The best treatment for most is still drug therapy.

What does DBS involve?

The procedure involves the implantation of a wire, with four electrodes at its tip, into one of three target sites in the brain:

- the thalamus (the procedure is known as thalamic stimulation)
- the globus pallidus (the procedure is pallidal stimulation)
- the subthalamic nucleus (the procedure is subthalamic stimulation)

The implantation procedure is performed in most centres under local anaesthetic with the person awake. The target site is then stimulated with a small electric current and the person's response monitored to confirm accurate target localisation. The wire is then connected to a small unit called an Implantable Pulse Generator (IPG), which is

implanted (under general anaesthetic) under the skin in the chest, rather like a pacemaker. The IPG contains the battery and electronics to generate the electrical signals for the stimulation. The IPG is programmed by the clinician using a computer, but on a day-to-day basis, the stimulation can be switched on and off by the person with Parkinson's using a hand-held programmer or a magnet.

When the stimulator is switched on, electrical signals are sent to the brain to stop or reduce the Parkinson's symptoms. When the stimulator is switched off, the symptoms return. Stimulation on the left side of the brain affects the symptoms on the right side of the body and vice versa. Bilateral stimulation to control symptoms on both sides of the body is now favoured and requires only one IPG, known as Kinetra.

At present, the battery in the IPG usually lasts for about four to five years. When the battery needs changing, it is necessary to replace the whole IPG under the skin in the chest but not the wire in the brain. The whole system is often called Activa Therapy.

What are the possible benefits of DBS?

DBS is a non-destructive form of surgery. This means that it does not destroy a part of the brain in the way the technique known as lesioning does, but instead mimics its effects. It is also reversible, so if the procedure is not successful, the IPG and the electrode can be removed. It is important to remember that DBS treats symptoms but it does not cure the underlying Parkinson's.

This means that most people who have DBS continue to need treatment with anti-



Parkinson's medication. However, as the Parkinson's progresses, the level of stimulation can be adjusted in order to maintain optimal control of the symptoms.

Thalamic Stimulation

Thalamic stimulation is licensed to treat Parkinson's tremor. It is used exclusively for people who have disabling tremor that is not controlled effectively by medication. It appears that the suppression of tremor achieved is of a similar level to that achieved with a very good anti-Parkinson's medication regimen. Surgical experience to date suggests that thalamic stimulation results in either a reduction or a complete suppression of tremor in about 80% of people with Parkinson's who have this surgery. Occasionally, however, the tremor reappears and some people derive no benefit at all. Bilateral thalamic stimulation is considered safer than bilateral thalamotomy (lesions).

We do not yet know whether the positive effects of thalamic stimulation are permanent. Some of the early recipients of the therapy have been followed up for more than ten years and the level of control over tremor that they have derived from thalamic stimulation seems to have been constant. However, Parkinson's is a progressive condition and symptoms such as bradykinesia (slowness of movement) and dyskinesia (involuntary movements associated with some Parkinson's medication), do deteriorate because they are not helped by thalamic stimulation. Most centres have now abandoned its use in Parkinson's in favour of pallidal stimulation and subthalamic stimulation, although they continue to use thalamic stimulation for essential tremor.

Pallidal Stimulation

Pallidal stimulation has been used to treat people with Parkinson's who have disabling levodopa-induced involuntary movements (dyskinesias). It can have a variable beneficial effect on dyskinesias and it usually helps stiffness (rigidity) and generally improves on time in people who experience the 'on/off' syndrome as a side effect of their medication. See the PDS information sheet Motor Fluctuations for information on dyskinesias and the 'on/off' syndrome. About 70–80% of people who have pallidal stimulation will derive some benefit. It may do little for slowness of movement (bradykinesia) and can sometimes even worsen it. Hence, subthalamic stimulation is favoured by most centres.

Subthalamic Stimulation

About 70–80% of people who have subthalamic stimulation will derive some benefit from it. In particular, the procedure can have a major beneficial effect on tremor, slowness of movement and stiffness. It can also have a positive effect on postural stability, gait and freezing. Most people who have had subthalamic stimulation have also been able to reduce significantly the dose of levodopa medication that they take, leading in turn to a reduction in the level of involuntary movements (dyskinesias) experienced. All aspects of 'off' periods caused as a side effect of levodopa drugs respond to subthalamic stimulation.

Some clinicians who have experience of performing both pallidal and subthalamic stimulation have now abandoned pallidal stimulation in favour of the latter because of its perceived greater beneficial effects. The lower stimulation voltage used in subthalamic



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stimulation also means a greater battery life, hence fewer replacements.

What are the possible risks or side effects of DBS?

Post-operative side effects of DBS are generally mild, temporary and reversible. The surgeon can also adjust the level of stimulation in order to minimise these effects. The possible side effects of the stimulation include: pain; swelling at the implant site; an allergic reaction to the implant; change of stimulation effectiveness over time; tingling in the face or limbs; speech and vision problems; dizziness; reduced co-ordination or movement problems; difficulty in maintaining attention or concentration; jolting or shocking sensation; temporary rebound worsening of the tremor when the stimulation is stopped. It is also possible that the electrode may move from the original implantation site.

There are some risks associated with the surgery itself and these include: bleeding in the brain (which causes damage that can lead to paralysis or, rarely, death if the damage is severe); leakage of fluid surrounding the brain (which can predispose to headaches or, in some cases, meningitis); infection and seizures. The risk of one of these serious events is about 5%. The risks of the surgery are increased in older people (aged more than 70–75 years) and those with other conditions, such as cerebrovascular disease and high blood pressure. Most surgeons would not perform DBS on someone who is experiencing confusion or psychosis, or who has severe depression.

Can I have diathermy after DBS?

People who have an implanted neurostimulation device should not have

diathermy on any part of their body as it can cause permanent nerve or tissue damage and result in injury or death.

Diathermy is a treatment that uses radio frequency (RF) energy or sound waves to heat a targeted part of the body. Healthcare professionals may refer to diathermy as using 'deep heat' or other similar descriptive terms. The goal of this therapy is typically to reduce swelling and stiffness of muscles and joints, as well as to promote healing of tissue following surgical procedures or injury. The heat generated by diathermy is thought to accelerate blood flow and metabolism, thus facilitating the process of absorption and tissue repair.

Diathermy is provided by a variety of health professionals, including physiotherapists, nurses, chiropractors, dentists and sports therapists. At least three forms of diathermy are in use in the medical community: radio frequency or shortwave diathermy; therapeutic ultrasound diathermy; microwave diathermy. All of these are contraindicated for people who have had DBS. NB: diagnostic ultrasound is different from therapeutic ultrasound diathermy. Diagnostic ultrasound is not contraindicated for people who have had DBS.

Surgical diathermy is slightly different. However, again, monopolar surgical diathermy should not be used during surgery and your surgeon should know that. Bipolar diathermy to stop bleeding during operations is quite safe if you have an implanted neurostimulator. Anyone who has had a DBS and who might be treated with diathermy should discuss this further with their specialist/neurosurgeon.



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Can I have an MRI scan once I have had DBS?

MRI (magnetic resonance imaging) scans are a radiology technique that uses magnetism, radio waves and a computer to produce images of the body structures.

MRI scans in the presence of an implanted DBS should be avoided if possible because some machines and the gadget (coil) by which MRI scans resonate through the body may produce unsafe heating of the implanted electrodes, leading to damage. However, MRI scans of the brain can be performed safely in people with Parkinson's who have had DBS, as long as the strength of the magnet is less than 2 Tesla and a trans-receive type of coil is used. It is also important that the output of the generator (IPG) is reduced to 0 as it will switch on/off during the MRI scan. Your specialist or neurosurgeon can advise further.

All hospitals should have an MRI safety policy in place and most hospitals which do not perform deep brain stimulation regularly would not allow patients who have deep brain stimulators to undergo MRI examination.

What is the cost of DBS?

The total cost of DBS varies, but it is generally £25,000–£30,000. This includes the DBS system, the surgery itself, inpatient stay and follow-up assessments. The NHS pays for a limited amount of operations each year, and some private health insurers may also fund it.

What is the outlook for DBS?

There are many unanswered questions concerning surgical techniques for Parkinson's, such as how long the beneficial results may last or if any procedures may delay the progression of Parkinson's. There is also some

debate over the benefits of lesioning against stimulation. Further research is needed.

The relative merits of surgery and medical treatment have never been assessed in a clinical trial until now, so all information could potentially be biased. The UK Medical Research Council and PDS have funded a large clinical trial to address this, called PD SURG. The results from this trial will give us a better understanding of whether the treatment works, who it is best for and if it is cost effective.

Future surgical therapeutic advances are aimed at replacing and/or restoring the dying dopamine cells. These currently remain largely experimental. With DBS being reversible, further treatment options are not precluded should they become generally available.

What other surgical techniques are currently used to treat Parkinson's?

Apart from DBS, the main surgical areas are:

- lesioning (pallidotomy, thalamotomy and subthalamotomy)
- gamma knife surgery
- brain implants using foetal brain tissue
- infusion of chemicals in the basal ganglia (the part of the brain affected in people with Parkinson's).

See the PDS booklet *Surgery and Parkinson's* for more details.

If you have DBS do you need to take precautions before having certain medical procedures?

If you have a DBS and you plan to have dental work or procedures, operations involving a general anaesthetic, or urinary catheterisation, it would be advisable to have prophylactic



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antibiotics. If you have hardware implanted in you, during these procedures, bacteria can land on the hardware and infect it. These antibiotics are given as a preventative measure. Hospitals and surgeons have different antibiotic policies in place for each of the procedures they perform. They should use a similar protocol as that used to prevent infection in a heart valve. Your doctor should be able to advise further.

Conclusion

DBS is an exciting development in Parkinson's treatment. However, it is not a suitable treatment for everyone and has some risks and side effects. The main treatment for most people who have Parkinson's is still drug therapy. Surgery will only be considered when the drugs are no longer adequately controlling symptoms. If you are considering deep brain stimulation or any other form of functional neurosurgery, you should consult your Parkinson's doctor for further advice.

Thanks

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215 Vauxhall Bridge Road, London SW1V 1EJ, UK

Tel: 020 7931 8080 **Textphone:** 0800 111 4204 **Fax:** 020 7233 9908

Helpline: 0808 800 0303 (The Helpline is a confidential service.

Calls are free from UK landlines and some mobile networks)

Email: enquiries@parkinsons.org.uk **Website:** www.parkinsons.org.uk

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